The Signaling Effects of Fiscal Announcements*

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Abstract

Fiscal announcements may transfer information about the government's view of the macroeconomic outlook to the private sector, diminishing the effectiveness of fiscal policy as a stabilization tool. We construct a novel dataset that combines daily data on Japanese stock prices with narrative records from press releases about a set of extraordinary fiscal packages introduced by the Japanese government from 2011-2020. We use local projections to show that these fiscal stimuli were often interpreted as negative news by the stock market whereas exogenous fiscal interventions that do not convey any information about the business cycle (e.g., the successful bids to host the Olympics on September 8, 2013) fostered bullish reactions. In addition, these negative effects on stock prices arose more commonly when fiscal stimuli were announced against a backdrop of heightened macroeconomic uncertainty. Both findings are shown to be consistent with the theory of signaling effects.

Keywords: fiscal stabilization policies, macroeconomic uncertainty, information, public expectations, natural experiment, Japan.

JEL classification: E62, E32, D83.

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1 Introduction

Fiscal policy is one of most classic topics in economics. However, most of the existing studies abstract away from the existence of signaling effects associated with fiscal interventions. Signaling effects of policy decisions emerge when the announced size of a policy decision conveys information about policymakers' assessment of the macroeconomic outlook to the private sector. For example, introducing a larger than expected fiscal stimulus package may be interpreted by economic agents as news that the recession is more severe than previously anticipated. This interpretation can engender negative private expectations about the severity of the ongoing contraction, blunting the stabilizing effects of fiscal policy.

To test for the existence of signaling effects associated with fiscal policy, we exploit two key predictions that emerge in a stylized general equilibrium model where the fiscal authority and the private sector have asymmetric information about the state of the economy. First, signaling effects do not arise if fiscal interventions are autonomous to business cycles. Examples of exogenous fiscal spending include a change of leadership in a country or the increase in government spending in the host country of the next Olympic games. Signaling effects only arise when fiscal policy is geared toward economic stabilization. This is the case of a fiscal stimulus aimed at mitigating a recession or at weathering the economic consequences of an extraordinary event that hits the economy very hard and abruptly (e.g., an earthquake or a pandemic). Second, signaling effects are stronger when they occur in periods when the private sector is highly uncertain about the economic outlook and consequently private sector's beliefs are more receptive to public news.

We construct a novel dataset that combines daily data on stock price index (Nikkei 225) with narrative records from press releases about sixteen supplementary fiscal packages introduced by the Japanese government in the period 2011-2020 to respond to events that threatened to worsen the economic outlook – such as the 2011 earthquake and the COVID-19 pandemic. We then apply the local projection method to our novel dataset to show that the response of stock market to these extraordinary fiscal measures aimed to stimulate the economy are not statistically significant. Nevertheless, we find that the stock market generally improves in response to exogenous fiscal spending events, such as the successful bid to host the 2020 Olympics and the 2025 Universal Exposition, and the victory of the Liberal Democratic Party lead by Shinzo Abe at the general election in 2012 and the subsequent raise in government spending. To be more specific, while the benchmark response of stock prices news to exogenous fiscal spending ranges within a rise of 1-3% in the three subsequent days to the announcements, we find a wide-ranging set of responses of stock prices to the fiscal announcements of the sixteen supplementary fiscal policy measures enacted in the period 2011-2021. Stock prices fell on the day of the announcements following three of these fiscal announcements and remained close to zero on average after nine announcements.

These findings are consistent with the theory of signaling effects according to which extraordinary fiscal interventions may also be interpreted by the private sector as bad news about the strength of the economy. Furthermore, when we add the stock market volatility index (Nikkei VI) to account for changes in uncertainty to the local projections, we find that uncertainty plays an important role in determining the sign of the effects of the sixteen supplementary fiscal packages on the stock market. Exactly as predicted by the theory of signaling effects, when macroeconomic uncertainty is heightened fiscal interventions have muted and at times even adverse effects on stock market prices.

An event-study approach (i.e., our decision on applying local projections to a selected numbers of fiscal interventions) is necessary to study signaling effects of fiscal policy because of the multifaceted purposes governments typically try to achieve with the fiscal tool. For instance, announcing an increase in military spending is typically unrelated to the business cycles and, therefore, does not convey any information about the government's view on the economic outlook. Other examples are announcements regarding the need to reform the pension system, or the expansion or renovation of infrastructure or spending more money in the school system. These are all announcements that are expected to boost aggregated demand and perhaps the economy but they do not reveal any information about the government's view of the economic outlook. As such, these announcements do not bring about signaling effects and are used in this paper to construct a useful benchmark to compare the response of stock prices to fiscal news that may reflect information about the ongoing economic conditions and thereby can give rise to signaling effects.

Ideal events for studying the signaling effects of fiscal policy are announcements of *unanticipated* and *large* fiscal packages designed to *combat a recession*, whose severity is largely *uncertain* at the moment of the announcement. Moreover, the announced fiscal package does not have to be anticipated because if it does, it would be hard to predict how the announcement influences private expectations. The announced fiscal stimulus, for instance, could be less aggressive than anticipated, signaling that the government believes that the economy is doing better than what the private sector expects. In the paper we run a number of robustness checks where we change the assumptions about when the first news about each of the sixteen supplementary fiscal packages arrived. We show that the selected dates linked with the timing and size of the fiscal interventions are those when the stock markets react strongly to the news for the first time. Numerical simulations of our simple model show that the signaling effects of fiscal policy are quantitatively sizeable and non-linear.

One potential drawback of using stock-market data is that in principle it is unclear how stock-market data should respond to exogenous fiscal shocks (i.e., an increase in government spending unrelated to the business cycle). While fiscal shocks lead to a temporary increase in the aggregate demand and output, they also bring about expectations of higher taxes, which have detrimental effects on the profitability of firms and hence on stock prices. To address this shortcoming, we study the response of stock prices to announcements of exogenous fiscal spending shocks that are independent from current economy conditions: the General Elections of the Liberal Democratic Party lead by Shinzo Abe on December 16, 2012, the successful bids to host the Olympics on September 8, 2013, and the Universal Exposition on November 24, 2018. Stock prices consistently increased in response to these announcements, ranging within a rise of 1-3% in the three subsequent days to the announcements, corroborating the view on the expansionary effect of exogenous government spending.

The estimation of stock prices response to these exogenous fiscal announcements serves an important purpose in our study. It provides us with a useful benchmark to investigate the signaling effects associated with the sixteen supplementary fiscal packages. Indeed, assessing the magnitude or even just the existence of signaling effects of macroeconomic policy is tricky because these effects are likely to work at the margin. For instance, the fact that private sector's expectations or stock prices improve or do not respond at all to news about a fiscal stimulus does not disprove the existence of signaling effects. It just shows that the more pessimistic beliefs due to signaling effects are dominated or fully offset by the stimulative effects of the announced stimulus. However, signaling effects may still be present and may negatively affect stock prices. Comparing the response of stock prices to news about the fiscal response to business cycles with the benchmark response of stock prices to exogenous fiscal news is critical to be able to evaluate potential signaling effects of fiscal policy.

Our second contribution is to develop a simple two-period model with imperfect information that shows how critical the link between macroeconomic uncertainty and the magnitude of signaling effects of fiscal policy. In our model, prices are rigid and thus firms rely on expectations on the state of productivity in the next period to set the optimal price, and stock prices depend on firms' expected profits, which are determined by the future productivity of firms. The fiscal authority receives some noisy information about the state of productivity one-period in advance to the private agents and uses the acquired information to set the level of government spending according to a counter-cyclical fiscal rule that stabilizes output around the equilibrium level. The fiscal plan is announced one period in advance. Private agents have prior beliefs on the future state of technology and can use the fiscal announcement to infer the state of technology in the next period, forming posterior beliefs that will shape expectations and thus influence optimal prices and stock prices.

Our stylized model shows that the announcement of an expansionary fiscal policy entails two opposing effects on the economy. First, the standard expansionary effect of fiscal policy for the increase in demand in consequence to the expansionary policy. Second, a contractionary effect that results from the signal of a reduction in productivity inherent to the announcement of the expansionary policy when the fiscal authority follows a counter-cyclical fiscal rule. In our framework that grants an information advantage to the fiscal authority, the expansionary fiscal announcement conveys non-redundant information on the realization of adverse economic fundamentals in the future, which private agents may use to update their beliefs towards a reduction in future output. Therefore, firms may optimally infer a future reduction in productivity from an expansionary fiscal policy, and therefore reduce prices and dividends in the current period.

The model shows that central to the strength of the signaling effects are the prior uncertainty of the private agents and the precision of information received by the government. When private agents are uncertain about future productivity, their prior is less informed and thereby wider. The sensitivity of agents' posterior beliefs on future productivity to the arrival of a fiscal news increases with the degree of agents' uncertainty. This result stems directly from standard Bayesian updating: the less uncertain agents are, the more dogmatic their prior is, the more sensitive agents' expectations are to news. Since agents know that fiscal policy is counter-cyclical, the announcement of an expansive fiscal policy signals an expected fall in productivity that leads firms to optimally reduce current prices and dividends fall.

Our analysis is chiefly related to studies that investigate the signaling effects in monetary policy. In this realm of research, Vickers (1986), Romer and Romer (2000), Campbell et al. (2012), Campbell et al. (2017), Melosi (2017), D'Amico and King (2013), Nakamura and Steinsson (2018), Cieslak and Schrimpf (2019), Jarocinski and Karadi (2020), Andrade and Ferroni (2021), Miranda-Agrippino and Ricco (2021) and Gáti (2021) show that announcements about monetary policy provide powerful signals on the future economic conditions that influence the expectations of market participants. A recent paper by Bauer and Swanson (2020) challenges the conclusions of these studies. We also relate to the research on the role of fiscal policy announcements in Ricco et al. (2016) and fiscal forward guidance in Fujiwara and Waki (2020).

We finally relate to the large literature that studies the role of imperfect information for the formation of expectations and the effect of monetary policy. Woodford (2002), Adam (2007), Gorodnichenko (2008), Nimark (2008), Lorenzoni (2009), Melosi (2014), Okuda et al. (2021) and several other studies show that imperfect information plays a critical role for the expectations about inflation and the optimal conduct of monetary policy. Different from the aforementioned studies, we are the first study that focuses on imperfect information in the context of fiscal policy.

The remainder of the paper is organized as follows. In Section 2, we develop a simple tracking model in which signalling effects can arise. We use this simple model to outline the key properties of the theory of signalling effects. In Section 3, we show that these properties extend to a microfounded two-period New Keynesian model with imperfect information. In Section 4, we provide preliminary evidence on the differential response of stock prices to fiscal announcements designed to stabilize the economy and to announcements that are *exogenous* to economic conditions. In Section 5, we introduce a new data set of fiscal announcements in Japan for the period 2011-2020, and show evidence of signaling effect of fiscal announcements. Consistently with the theory, we document a significant interplay between the private sector's prior economic uncertainty and the signaling effects of fiscal announcements. In Section 6, we quantify the signaling effects of fiscal policy on output. In Section 7, we present our conclusions.

2 A Simple Model of Signaling Effects

This section lays out a simple model that outlines conditions and key properties of signaling effects of economic policies, which will guide our empirical investigation and provide the foundations to the microfounded model in Section 3.

The behavior of the economy is summarized by a univariate process driving a scalar, X_t, which we call the economic variable, economic conditions, or the economy. We assume that agents do not observe this variable and have to track it using two sources of information: (i) a non-policy source of information, captured by the signal s_t about X_t, which is perfectly observed by every agent and (ii) the policy actions taken by the government or policymaker in response to the economic variable X_t. The government takes the action a_t in every period with the aim to stabilize the dynamics of the economic variable X_t. The action is perfectly observed by every agent of the economy. Agent know the model structure (i.e., the equation and the parameter values), which is formalized below.

We assume that agents' expectations, $X_{t|t}$ have feedback effects on the economic variable, X_t. The policymaker can stimulate the economic variable, X_t, by increasing its policy tool a_t. The economic variable is also affected by an i.i.d. Gaussian shock, ε_t. In symbols,[1]

$$X_t = \gamma a_t + \lambda X_{t|t} + \varepsilon_t, \qquad \gamma > 0 \text{ and } \lambda \neq 0, \tag{1}$$

where $\varepsilon_t \sim \mathcal{N}\left(0, \sigma_\varepsilon^2\right)$. The parameter $\gamma > 0$ encapsulates the positive effects of policy on the economic variable. The parameter λ controls the feedback effect of agents' beliefs. If $\lambda > 0$, expectations can be regarded to some extent self-fulfilling. We make this assumption throughout this section.

The government takes an action a_t in every period t with the objective of stabilizing the dynamics of the economic variable X_t.

$$a_t = \alpha E_t^g X_t + \tau_t, \qquad \alpha \leq 0, \tag{2}$$

where $\tau_t \sim \mathcal{N}\left(0, \sigma_\tau^2\right)$ is a policy shock and $E_t^g(\cdot)$ denotes the expectations of the government, which are defined as follows:

$$E_t^g\left(X_t\right) = X_t + \mu_t, \tag{3}$$

with a measurement error $\mu_t \sim \mathcal{N}\left(0, \sigma_\mu^2\right)$.

[1] Since all the shocks in the model are i.i.d. and, for simplicity, there is no inertia in the model equation (1), agents expectations about future realizations of the economic variable $X_{t+h|t}$ are always equal to zero and thereby do not affect the dynamics of the economic variable, X_t.

The non-policy signal is defined as follows:

$$s_t = X_t + \xi_t, \tag{4}$$

with noise $\xi_t \sim \mathcal{N}\left(0, \sigma_\xi^2\right)$.

Note that agents have the same information set (no asymmetric information) and since they know the model structure, their beliefs, $X_{t|t}$, are common knowledge.[2] Their information set is $I_t^p = \left\{a_t, s_t, X_{t|t}\right\}$. However, agents' information set differs from the information set of the government (implying that $X_{t|t} \neq E_t^g(X_t)$). The difference in the information set is critical to allow the government's actions to transfer non-redundant information to agents.[3]

The system can be written as follows:

$$X_t = \gamma a_t + \lambda X_{t|t} + \varepsilon_t, \tag{5}$$

$$a_t = \alpha X_t + u_t, \tag{6}$$

$$s_t = X_t + \xi_t, \tag{7}$$

where $u_t \equiv \tau_t + \alpha\mu_t$. Note that if $\alpha = 0$, the shock u_t is just a policy shock (i.e., $u_t = \tau_t$). If $\alpha < 0$, this shock is also affected by autonomous changes in beliefs, which are encapsulated by the shock μ_t.

Details on how to solve this simple model of tracking is provided in the Appendix. The solution is given by:

$$X_{t|t} = \left(\frac{1-\alpha\gamma}{1-\alpha\gamma-\lambda}\right) \cdot \mathbf{K} \begin{bmatrix} \left[\frac{\alpha\gamma}{1-\alpha\gamma}+1\right] u_t + \frac{\alpha}{1-\alpha\gamma}\varepsilon_t \\ \frac{\gamma}{1-\alpha\gamma} u_t + \frac{1}{1-\alpha\gamma}\varepsilon_t + \xi_t \end{bmatrix}, \tag{8}$$

where $\mathbf{K}$ denotes the 1×2 Kalman gain matrix, which is defined in Appendix A.1.

[2]See Melosi (2017) for a case in which agents have different information about the economy and optimally respond to their forecasts of the forecasts of others.

[3]As we shall see, the other important feature for signaling effects to arise is that government actions respond to the economic variable (i.e., $\alpha \neq 0$).

Parameter Values

	No Response	Weak Response	Strong Response
α	0.00	-1.00	-2.00
γ	0.50	0.50	0.50
λ	0.75	0.75	0.75
σ_ε	1.00	1.00	1.00
σ_u	0.10	0.10	0.10

Table 1: **Parameter values.** Each column shows the parameter values used in three numerical exercises. The three cases only differ in how stringly the government responds to the economic variable (α).

2.1 Signaling Effects and Private Sector's Uncertainty

In this section, we conduct some numerical exercises to show some basic properties of the theory of signaling effects. Specifically, we will show that the magnitude of signaling effects varies with the government's degree of responsiveness to economic conditions (α). In the case of no response ($\alpha = 0$), there is no signaling effects because the government does not respond to the economy, X_t, and, consequently, its action, a_t, does not convey any information about the economy. When the government responds to the economy ($\alpha < 0$), signaling effects kick in affecting agents' beliefs about the economy ($X_{t|t}$) and – provided that there is feedback from agents' beliefs to the economic variable ($\lambda \neq 0$) – economic outcomes as well. In particular, we want to focus on how agents' uncertainty prior to observing the policy signal (σ_ξ) influences the size of signaling effects. We will later exploit this interaction between signaling effects and private uncertainty to show the existence of signaling effects associated with the introduction of supplementary fiscal packages enacted by the Japanese government.

Table 1 shows the parameter values used in the numerical exercises. The first exercise ("No Response") is the case in which the government does not respond to economic variable ($\alpha = 0$), and so signaling effects do not emerge by construction. It is worth noting that in the case of no policy response to economic variable, changes in the policy action are driven by independent policy shocks (τ_t) whose magnitude is perfectly observed by agents. In the literature on fiscal multipliers, these shocks are the closest counterpart of discretionary changes in government spending. These discretionary changes do not give rise to signal effects as they are exogenous. In the second and third cases, the government tries to maneuver its policy instrument, a_t, to respond to *perceived*

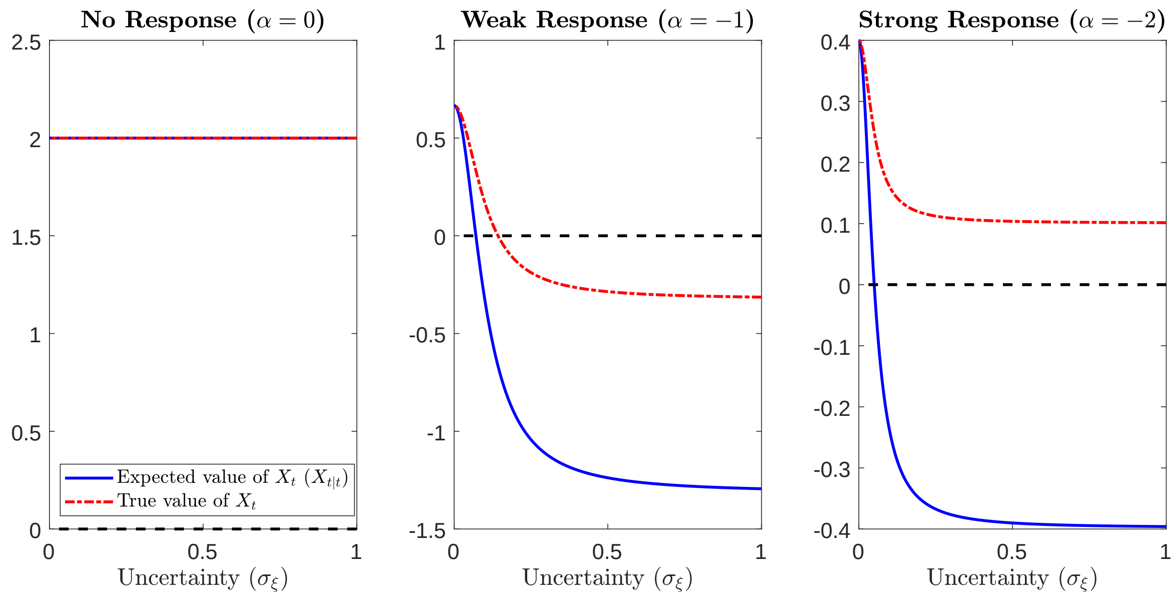


Figure 1: **Signaling Effects of Economic Policy.** The response of agents' expectations, $X_{t|t}$, (blue solid line) and the economy, X_t, (red dotted-dashed line) to an autonomous increase in the policy action ($u_t > 0$) as the private sector's prior uncertainty, σ_ξ, varies on the horizontal axis. On the left, the case of weaker policy response ($\alpha = -1$). On the right, the case of stringer policy response ($\alpha = -2$)

changes in the economic variable $E_t^g(X_t)$. We assume that these changes in government's beliefs are driven by noise/error (μ_t). Since the parameter $\alpha \neq 0$, agents do not know if the observed changes in the policy actions is driven by a policy shock (τ_t), or noise (μ_t), or by a change in the unobserved economic condition (X_t). Since the private sector cannot rule out the latter possibility, policy actions transfer information about the economy to agents. We consider two subcases: one case of a weak policy response ($\alpha = -1$) and one of a strong policy response ($\alpha = -2$). We want to establish whether signal effects become stronger if the government is more proactive in stabilizing the economy (X_t).

Figure 1 shows the response of private sector's expectations about the economy ($X_{t|t}$) (solid blue line) to an autonomous change in the policy actions u_t as private sector's uncertainty prior to observe the policy action, σ_ξ, increases. The figure also shows the response of the economy to an autonomous change in the policy actions u_t (red dotted-dashed line) as private agents' prior uncertainty σ_ξ varies. The three subplots show the three cases: No signaling ($\alpha = 0$) on the left, the case of a weak government's response to the economy ($\alpha = -1$) in the middle, and the case of a strong government's response to the economy ($\alpha = -2$).

The signaling effects are defined as the deviation of the economic variable from the value it would have assumed if agents were perfectly informed. Agents are perfectly informed when their prior uncertainty is zero ($\sigma_\xi = 0$). The left graph of Figure 1 shows that when the government does not respond to the economy, exogenous changes in government actions (τ_t) do not trigger signaling effects. In this case, neither beliefs nor outcomes are affected by variation in private sector's prior uncertainty.

In the middle graph, government actions, a_t, respond to changes in the economic environment ($\alpha < 0$). In this case, both agents' beliefs about the economy and the economy are affected by signaling effects. This can be seen by observing how beliefs ($X_{t|t}$, the blue solid line) and economic conditions (X_t, the red dashed-dotted line) falls as the private sector's prior uncertainty rises. For positive values of the prior uncertainty ($\sigma_\xi > 0$) both variables ($X_{t|t}$ and X_t) are lower than their perfect-information values, which arise when there is no prior uncertainty ($\sigma_\xi = 0$). But why do signaling effects lowers beliefs and harms the economy? Because policy actions have the dual nature of economic policy and signal about the economy. This duality implies that if the government raises its instrument a_t, rational agents understand that the policy tool may have been increased in response to deteriorating economic conditions ($X_t < 0$).

Furthermore, and critical for the empirical analysis that follows, as agents' prior uncertainty (σ_ξ) increases, agents' expectations about the economic variable ($X_{t|t}$) are more responsive to policy signaling and consequently signaling effects become stronger. See the solid blue line in the middle and the right plots. Signaling effects grow with the private sector's prior uncertainty because as the private signal becomes more inaccurate, agents rely more on the public signal to learn about the economic condition X_t. Since rational agents know that the government increases its policy action a_t when the economic condition deteriorates, agents will lower their expectations. Since private sector's expectations simultaneously feed into economic conditions, X_t, the economy deteriorates as a result of signaling effects. When uncertainty is sufficiently high, the private signal is sufficiently unreliable that the policy action a_t is the only reliable signal about the economic condition. In this case, signaling effects are so strong that agents' beliefs *worsen* ($X_{t|t} < 0$, the blue solid line) in response to an *expansionary* policy action, ($a_t > 0$). Since agents' beliefs feed back to the economic conditions, X_t, large signaling effects can even imply a perverse *negative* response of the economy (X_t, the red dashed-dotted line) to the *expansionary* policy action ($a_t > 0$).

Comparing the middle and right plots, there is yet another prediction of the theory of signaling effects of economic policy. As the government becomes more proactive in using its policy tools a_t to stabilize the economy X_t, signaling effects become smaller. The degree of government's proactivity is controlled by the parameter α. You can see that when this parameter is twice as big (right plot), the economy does not contract in the aftermath of an expansionary policy shock regardless of the level of prior uncertainty, σ_ξ. The stronger stabilization effort by the government reduces the volatility of the economic variable X_t and, hence, for a given level of prior uncertainty, agents' expectations, $X_{t|t}$, are less sensitivity to signaling effects. As agents' expectations fall less, the economy, X_t, does not shrink following the fiscal intervention.

To sum up, this simple tracking model highlights four key properties of the theory of signaling effects. First, if an action is understood by the private sector to be exogenous, there is no signaling effects. Second, the larger the private sector's prior uncertainty, the more sizable the signaling effects in response to a policy action. Third, if private uncertainty is sufficiently large, the response of beliefs and economic conditions to economic policies can be the opposite to what expected under perfect information. Fourth, strong systematic policy responses to economic conditions help mitigate signaling effects.

3 A Model of Signaling Effects of Fiscal Announcements

The previous model was a tracking model without any theoretical microfoundation. Nonetheless, the model is endowed with the minimal parametric restrictions needed for economic policies to have signaling effects. In this section, we show that the main lessons we learned about signaling effects from the stylized tracking problem hold true in a microfounded two-period New Keynesian model.

In the model, the government and the private sector (households and firms) have asymmetric information about the second period's labor productivity. The government announces a spending plan that is perfectly observed by the private sector and that will be implemented in the next period. This plan is understood to reflect the information that the government has regarding next period's productivity and is perfectly observed by everyone in the model. The private sector is rational and knows the fiscal rule used by the government for the announcement. Consequently, the private sector can use the announced plan to revise the prior belief about the second period's labor productivity. The revision to expectations is the signaling effects associated with the announced fiscal plan.

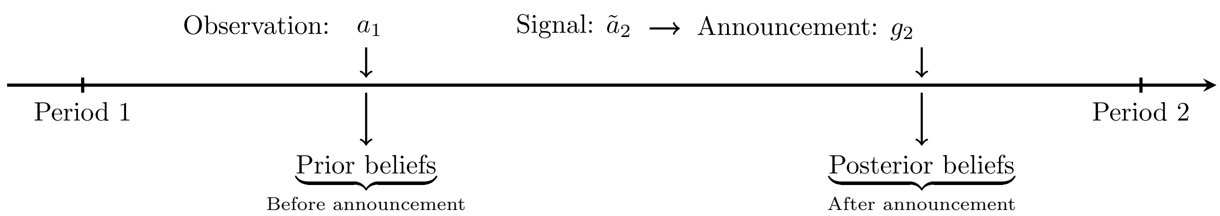
This stylized macroeconomic model allows us to show that the fiscal announcements may provide a negative signal or bad news to the private sector and generate negative expectations on stock prices. We will show that how bad the news delivered by the fiscal authority is depends on the private sector's prior uncertainty and the precision of information received by the fiscal authority. In addition, themagnitude of the signaling effects of fiscal policy depends on the degree of nominal rigidities and households' risk aversion.

3.1 Economic Environment

Time is discrete and has two periods. The economy is populated by a continuum of households, a production sector and a fiscal authority. The maximization problem of each agents is standard: households consume and earn labor income; profit maximizing firms manufacture goods in a monopolistically competitive market and sell their output to households for an established price that is subject to a Calvo contract; and the fiscal authority sets public spending according to a counter-cyclical fiscal rule.

Our model entails asymmetric information between the government and the private sector (households and firms) about future labor productivity. Firms adopt Bayesian learning on the fiscal announcements by the government. In period 1, agents observe current productivity (a_1) and the fiscal authority receives a noisy signal about the realization of productivity in period 2 ($\tilde{a}_2$) in advance to the private sector. Based on the signal received in period 1, the government sets the amount of public spending for period 2 (g_2), and discloses the fiscal spending plan to market participants immediately. The intermediate goods-producing firms use the fiscal announcement to infer productivity in the next period and update beliefs on the state of the economy in the next period. The firms use the posterior beliefs to set the optimal price that maximizes profits in the second period. The effect of the fiscal announcement is reflected by the changes in stock prices, which are equal to the discounted-value of expected profits over the two periods.

Figure 2 summarizes the timing of the acquisition, release, and processing of information. Our main focus is on the effect of the announcement of government spending in the formation of the posterior beliefs that are an important input in the optimal decisions by market participants, which we study in the next section.



Notes: In period 1, agents observe current productivity (a_1) and have prior uncertainty on the state of the economy. The government receives a signal about productivity in period 2 ($\tilde{a}_2$), sets government spending plan for period 2 (g_2) and announces the fiscal plan before the end of period 1. Based on the fiscal announcement, agents form posterior beliefs.

Figure 2: The acquisition, release, and processing of information

3.2 Information Structure

In period 1, both the private sector and the government observe the current level of productivity a_1. At the end of period 1, the private sector and the government receive two distinct pieces of news about period 2's productivity a_2. The government receives a noisy signal about next period's productivity. The private sector receives the government's announcement about the spending plan in period 2, which reflects the signal the government has observed. The government announces next period's spending right after it observes the signal about next period's productivity. In period 2, the private sector makes its economic decisions (consumption, labor, price setting) based on its (posterior) belief about the productivity in the period, a_2. Analogously, in period 2 the government is assumed to implement the level of spending, g_2, that was announced in period 1.

Private sector's posterior beliefs. The private sector observes the productivity at the beginning of period 1 (a_1), and based on it form its prior beliefs on productivity in period 2 (a_2) –i.e., the private sector's beliefs prior to receiving the fiscal signal. We assume that the private sector forms its prior beliefs using a random walk for the process of technology; that is,

$$a_2 = a_1 + u, \tag{9}$$

where $u \sim N(0, \sigma_u^2)$ is a white-noise shock with variance σ_u^2 that hits productivity in period 2. In period 1, before receiving the fiscal announcement, the private sector's prior beliefs about the level of productivity in period 2 is denoted by $\pi(a_2)$. It is immediate to see that the private sector expects productivity in period 2 to be the same as the level of productivity observed in period 1

(a_1). Private sector's prior uncertainty regarding the realization of productivity in period 2 is given by σ_u^2.

In period 1, the fiscal authority receives a noisy signal on productivity in period 2 ($\tilde{a}_2$) and, based on the signal, announces the spending plan for period 2 using a fiscal rule known by the private sector (defined below). The signal on productivity received by the government includes an error, and it is described by the following process:

$$\tilde{a}_2 = a_2 + v, \tag{10}$$

where $v \sim N(0, \sigma_v^2)$ is a white-noise error with variance σ_v^2 on the realization of productivity in period 2, and the inverse of the variance of the error $(1/\sigma_v^2)$ represents the precision of the information received by the government. If $\sigma_v^2 = 0$, the government perfectly observes productivity in period 2, and the higher the value of σ_v^2, the nosier and more imprecise the signal.

In period 1, the government announces the spending planned for the second period, g_2 in response to the signal about productivity received, $\tilde{a}_2$. Since private agents are rational, they know the reaction function linking the amount of planned public spending g_2 to the signal received by the government in period 1, $\tilde{a}_2$. Thus, they use the spending plan (g_2) announced by the government in period 1 to exactly recover the signal $\tilde{a}_2$ received by the government.

The private sector uses the fiscal announcements to form posterior beliefs on productivity in period 2 (i.e., $\pi(a_2 \mid g_2)$) according to the Bayes' rule:

$$\pi(a_2 \mid g_2) \propto f(g_2 \mid a_2)\pi(a_2), \tag{11}$$

where $f(g_2 \mid a_2)$ is the conditional distribution of government spending for a given technology in period 2, and $\pi(a_2)$ is the prior beliefs on technology in period 2. Given the prior beliefs and the inference of the signal from the policy announcement, we use equations (9) and (10) to derive the analytical solution for the posterior distribution of beliefs on productivity in period 2 given the fiscal announcement:[4]

$$a_2 \mid g_2 \sim N(\hat{a}_2, \hat{\sigma}^2), \tag{12}$$

[4] Appendix A.2 provides the derivation for the posterior distributions.

where

$$\hat{a}_2 = E_1(a_2 \mid g_2) = \frac{\hat{\sigma}^2}{\sigma_u^2} a_1 + \frac{\hat{\sigma}^2}{\sigma_v^2} \tilde{a}_2, \quad \text{and} \quad \hat{\sigma}^2 = \left(\frac{1}{\sigma_u^2} + \frac{1}{\sigma_v^2} \right)^{-1}. \tag{13}$$

Proposition 1. *Given the announcement of the fiscal plan (g_2) and the precision of the signal received by the fiscal authority (σ_v^2), the expected level of productivity in period 2 ($\hat{a}_2$) positively comoves with the signal on productivity ($\tilde{a}_2$), and the comovement increases with the prior uncertainty of the private sector (σ_u^2).*

Proof. See Appendix A.2. □

Proposition 1 establishes the positive link between the expectations of the private sector and the signal of productivity received by the fiscal authority that is revealed by the fiscal announcement. Important for our analysis, the strength in the relation increases with the prior uncertainty of the private sector and the precision of the signal received by the government. This result stems directly from Bayesian updating: the less uncertain agents are, the more dogmatic the prior is, the more sensitive agents expectations are to new information.

3.3 Households and Firms

During each period $t = 1, 2$, the representative household gains utility from consumption c_t and disutility from supplying labor n_t to the intermediate goods-producing firm. The two-period utility function is:

$$E_1 \left[\left\{ \frac{c_1^{1-\gamma}}{1-\gamma} - \chi n_1 \right\} + \beta \left\{ \frac{c_2^{1-\gamma}}{1-\gamma} - \chi n_2 \right\} \right], \tag{14}$$

where the parameters $\beta \in (0, 1)$, and $\gamma \geq 0$ represent the discount factor, and risk aversion, respectively, and the free parameter $\chi \geq 0$ determines the steady-state value for the supply of labor. The budget constraints in each period $t = 1, 2$ are:

$$\begin{aligned} P_1 c_1 + \frac{B_1}{R_1} &= W_1 n_1 + D_1 - P_1 \tau_1, \\ P_2 c_2 &= W_2 n_2 + B_1 + D_2 - P_2 \tau_2, \end{aligned} \tag{15}$$

where P_t is the price level, W_t is the nominal wage, D_t is nominal dividends, and τ_t is real lump-sum taxes. Also, B_1 is the quantity of nominal bond issued in period 1 and R_1 is the gross nominal interest rate in period 1. Households choose consumption and labor supply to maximize (14) subject to the intertemporal budget constraint:

$$P_1 c_1 + \frac{P_2 c_2}{R_1} = W_1 n_1 + \frac{W_2 n_2}{R_1} + D_1 + \frac{D_2}{R_1} - P_1 \tau_1 - \frac{P_2 \tau_2}{R_1}. \tag{16}$$

The composite consumption good c_t comprises a continuum of differentiated goods $c_t(j)$, where $j \in [0,1]$, bundled together by the constant-elasticity-of-substitution (CES) aggregator:

$$c_t = \left(\int_0^1 c_t(j)^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}}, \tag{17}$$

where ε is the elasticity of substitution between different intermediate goods.

Each producing firm $j \in [0,1]$ manufactures a distinct good j according to the production function:

$$y_t(j) = e^{a_t} n_t(j)^{\alpha}, \tag{18}$$

where $n_t(j)$ is labor input, a_t is aggregate productivity, and $0 < \alpha < 1$. In each period t, a fraction $1 - \zeta$ of the firms reset the price optimally, while the remaining fraction ζ maintains the price unchanged. We assume that each firm sets the price $P_t(j)$ one period in advance before observing productivity in period. In our two-period economy this assumption leads the fraction $1 - \zeta$ of firms to set $P_2^*(j)$ in period 1 to maximize the present expected value of profits in period 2, weighted by the marginal utility of consumption:

$$\max_{P_2^*(j)} E_1 \left[(1/c_2^{\gamma}) \left\{ P_2^*(j) y_2(j) - W_2 n_2(j) \right\} \right] \tag{19}$$

subject to the demand function

$$y_t(j) = \left(\frac{P_t(j)}{P_t} \right)^{-\varepsilon} y_t, \tag{20}$$

and the production function (18), where the price level for the composite good is obtained by substituting equation (20) into equation (17) and it is equal to:

$$P_t = \left(\int_0^1 P_t(j)^{1-\varepsilon} dj \right)^{\frac{1}{1-\varepsilon}}. \tag{21}$$

The resulting optimal price in period 2 is:

$$P_2^* = \frac{\varepsilon}{\varepsilon - 1} E_1 \frac{W_2}{\alpha e^{a_2} n_2^{\alpha-1}}. \tag{22}$$

Using the price level in equation (21), the aggregate price in period 2 is:

$$P_2^{1-\varepsilon} = \zeta P_1^{1-\varepsilon} + (1-\zeta)(P_2^*)^{1-\varepsilon}. \tag{23}$$

Similar to the optimal price for period 2 in equation (22), the price in period 1 (P_1) is:

$$P_1 = \frac{\varepsilon}{\varepsilon - 1} E_0 \frac{W_1}{\alpha e^{a_1} n_1^{\alpha-1}}. \tag{24}$$

3.4 The Fiscal Authority

In each period $t = 1, 2$, the fiscal authority sets the level of government expenditure g_t using the information from the signal about aggregate productivity and using the following counter-cyclical fiscal rule that uses public spending to offsets movements in the signal of technology:

$$(g_t/g_{ss}) = \left(e^{\tilde{a}_t}\right)^{\psi}, \tag{25}$$

where $\psi < 0$ captures the degree of counter-cyclical adjustment of government spending to the signal of productivity received in the next period ($\tilde{a}_t$). The parameter g_{ss} is the steady state of government expenditures. Once the fiscal authority receives the signal $\tilde{a}_{t+1}$ at the end of period t, it immediately announces the level of government spending for the next period $t+1$ (g_{t+1}) to the private sector before the end of period t. Given our information assumptions, $\tilde{a}_1$ is equal to the realization of productivity in period 1 ($\tilde{a}_1 = a_1$) while $\tilde{a}_2$ is the acquired noisy signal of productivity in period 2. For simplicity, we assume that the fiscal authority balances the budget in each period using lump-sum taxes ($g_t = \tau_t$).

3.5 Equilibrium Conditions

In each period $t = 1, 2$, the equilibrium condition in the goods market is:

$$y_t = c_t + g_t, \tag{26}$$

the equilibrium condition in the labor market is: $n_t = \int_0^1 n_t(j)dj$, and the aggregate production function is: $y_t = e^{a_t} n_t^{\alpha}$. In period 1, the gross inflation rate is equal to one, $\Pi_1 = P_1/P_0 = 1$, and the nominal interest rate is at the steady state, $R_1 = R$.[5] In addition, the exogenous share of government spending to output is equal to $\theta = g/y$.

3.6 Stock Prices, Beliefs, and Fiscal Announcements

We now want to study how stock prices and the posterior beliefs of the private sector respond to fiscal announcements. Stock prices equal the sum of dividends in period 1 and expected, discounted dividends from monopolistically-competitive firms in period 2. Since agents are rational and know the fiscal rule, they recover the exact signal observed by the government from the fiscal announcement. Note also that the assumption of rationality implies that private agents also know the precision of the signal received by the government. They use this non-redundant information to update the prior beliefs on productivity in period 2 and form posterior beliefs, which determine the expected dividends and current asset prices.

Before the fiscal authority announces the government-spending plan for period 2, stock prices reflect the agents' prior beliefs on productivity in period 2, formed by observing productivity in period 1, and are equal to:

$$Q \mid a_1 = D_1 + \frac{E_1[D_2 \mid a_1]}{R}, \tag{27}$$

where $D_1 \equiv P_1 y_1 - W_1 n_1$, and $E_1[D_2 \mid a_1] = D_1$, resulting from the random walk process of productivity in equation (9).[6]

[5]This standard assumption is based on the presumption that the economy is in the steady state at the beginning of period 1, and firms expect the economy to remain in the steady state. A constant interest rate level is consistent with a Taylor rule that sets the nominal interest rate in response to the deviation of inflation from the steady-state level of inflation, where the gross rate of inflation is unitary.

[6]Under the assumption of no uncertainty in period 1's productivity (i.e., $E_0[a_1] = a_1$), equation (24) can be rewritten as $W_1 n_1 = \alpha(\varepsilon - 1)P_1 y_1/\varepsilon$. Using this equation with equation (18) for the production function into the

Private agents use the information conveyed by the fiscal announcement to update beliefs on productivity in period 1, and form posterior beliefs on the stock prices given the fiscal announcement, which are given by

$$Q \mid g_2 = D_1 + \frac{E_1[D_2 \mid g_2]}{R}, \tag{28}$$

where $E_1[D_2 \mid g_2] = P_2 E_1[y_2 \mid g_2] - E_1[W_2 \mid g_2] E_1[n_2 \mid g_2]$. Equation (28) shows how the announcement of the government-spending plan for period 2 (g_2) influences the conditional expectation for dividends in period 2 and thus stock prices in period 1. Proposition 1 established that the fiscal announcement has a stronger effect on expected productivity in period 2 the higher is the prior uncertainty of the private sector. This happens because productivity becomes hard to forecast if the possible realizations of productivity in the next period are wider, and therefore the private sector is more uncertain and use the announcement on the fiscal plan to infer the state of productivity in period 2.

3.7 Analytical Properties

To study analytically the effect of the fiscal announcement on expected dividends in period 2 and stock prices (i.e., $E_1[D_2 \mid g_2]$ and $Q \mid g_2$), we linearize the system around the stationary steady state, and use a caret symbol on a variable to represent the deviation of the variable from the stationary steady state.[7] The next proposition establishes the separate channels that determine the effect of the fiscal announcement on dividends and stock prices.[8]

Proposition 2. *The response of expected dividends in period 2 ($\hat{D}_2$) and stock prices in period 1*

definition of $D_1 \equiv P_1 y_1 - W_1 n_1$, it yields: $D_1 = \{\varepsilon - \alpha(\varepsilon - 1)/\varepsilon\} P_1 e^{a_1} n_1^{\alpha} = \{\varepsilon - \alpha(\varepsilon - 1)/\varepsilon\} e^{a_1}$. Since P_1 and n_1 are normalized and equal to one in the steady state. Thus, a_1 determines the level for D_1.

[7]Appendices A.3 and A.4 show the analytical solutions for the two-period model and the steady state of the model, respectively.

[8]The model is sufficiently simple to obtain analytical solutions by linearizing the system around the non-stationary steady state. Appendix A.5 derives the linear system.

($\hat{Q}$) to the announcement of government spending for period 2 ($\hat{g}_2$) are equal to:

$$\hat{D}_2 = \frac{1}{\Psi}\left\{\kappa^{No\ Signal} + \kappa^{Signal}\right\}\hat{g}_2, \tag{29}$$

$$\hat{Q} = \frac{\beta}{1+\beta}\hat{D}_2, \tag{30}$$

where:

$$\Psi = \{\varepsilon + (1-\varepsilon)\alpha\}\{(1-\theta)(1-\alpha)(1-\zeta) + \alpha\gamma\} > 0, \tag{31}$$

$$\kappa^{No\ Signal} = \gamma\theta\left\{(1-\alpha)(1-\zeta)\varepsilon + \alpha\right\} > 0, \tag{32}$$

$$\kappa^{Signal} = [(1-\theta)(1-\zeta)\{\varepsilon + (1-\varepsilon)\alpha\} + \gamma\{(\varepsilon-1)\alpha - \varepsilon(1-\zeta)\}] \cdot \frac{\omega}{(1+\omega)\psi} \gtreqless 0, \tag{33}$$

and $\omega = \sigma_u^2/\sigma_v^2$ is the prior uncertainty of the private sector relative the imprecision of the signal received by the government.

Proof. See Appendix A.5. □

Proposition 2 shows that the fiscal announcement exerts two opposing forces on expected dividends and stock prices. On the one hand, the announcement involves the standard expansionary effect of government spending, captured by $\kappa^{No\ Signal}$ in equation (29), which is positive and leads to an increase in expected dividends and stock prices. On the other hand, the fiscal announcement entails signaling effects on dividends, captured by κ^{Signal} whose sign is ambiguous, as outlined by equation (33). The parameter κ^{Signal} encapsulates the signalling effect since involves ω and ψ that are critical for the expectations about the level of productivity in period 2. For a given fiscal announcement, the strength of signaling effect depends on change in the expected productivity in period 2, depending on the degree of countercyclical fiscal policy (ψ) and the dispersion in the agents' prior belief relative to the precision of information received by the government ($\omega = \sigma_u^2/\sigma_v^2$).[9]

If κ^{Signal} is negative and larger than $\kappa^{No\ Signal}$ in absolute value, stock prices fall in response to an expansionary fiscal announcement. But Proposition 2 shows that the signaling effects do not have to be so strong to lead to a negative response of stock prices to fiscal announcements. By causing κ^{Signal} to be negative or less positive, signaling effects dampen the response of stock market prices to fiscal news. Thus, an important result of our analysis is that fiscal policy entails signaling

[9] Appendix A.6 shows that the sign of the coefficient κ^{Signal} is negative with minimal degree of nominal price rigidities. The intuition is straightforward: firms largely rely on expectations if they cannot readjust prices in every period, and thus signals about future productivity becomes powerful to influence output and stock prices.

effects that hampers the expansionary effect of the fiscal stimulus on output, despite the response of stock prices to the announcement of the fiscal plan may be positive.

Central to our analysis, the magnitude of the signaling effect of fiscal policy increases with the prior uncertainty of the private sector relative the precision of the signal received by the government (ω) and it decreases with the cyclicality in the systematic response of fiscal policy (ψ), as we establish by the next proposition.

Proposition 3. *The signaling effects of fiscal policy on stock prices:*

(i) it increases with the prior uncertainty of agents for a given precision of the information received by the government ($\omega = \sigma_u^2/\sigma_v^2$), and

(ii) it decreases with the cyclicality in the systematic response of fiscal policy (ψ).

Proof. Direct implication from equation (33). □

Part (i) of Proposition 3 establishes that the signaling effects of fiscal announcements are positively related to the prior uncertainty of agents in their own beliefs, captured by the parameter ω. If private agents have high prior uncertainty, they form expectations about productivity in the period 2 largely relying on the fiscal announcement, as shown in Proposition 1. Thus, the higher the prior uncertainty, the stronger the effect of the announcement of the fiscal plan on future dividends and stock prices, and the more powerful the signaling effects of fiscal policy.

Part (ii) of Proposition 3 establishes that the signaling effects of the fiscal announcement decreases with the cyclicality in the systematic response of fiscal policy to changes of aggregate productivity, controlled by the parameter ψ. If the systematic response of fiscal policy is largely insensitive to movements in aggregate productivity, the announcement of a large spending plan reveals to the private sector that the government received a signals of a large reduction in productivity for period 2, which triggers a sharp fall in expected dividends for period 2 and it generates a drop in stock prices in period 1. On the contrary, if the systematic response of fiscal policy is strongly counter-cyclical, the announcement of a large fiscal plan reflects the strong countercyclical policy rather than the large drop in the signal of productivity in period 2. Thus, the fall in stock prices in period 1 is limited.

The next lemma states the extent to which the strenght of the signaling effects depends on the structure of the economy.

Lemma 1. *The signaling effects of fiscal policy increase in the degree of nominal rigidities (ζ) and risk aversion (γ).*

Proof. See Appendix A.6. □

The strength of the signaling effects of fiscal policy is proportional to the degree of nominal rigidities. If prices are fully flexible and firms are able to adjust prices in every period, the signal on future economic conditions encompassed in the fiscal announcement becomes irrelevant for the profit maximization by firms, since firms can re-set prices after observing productivity and consequently the fiscal announcement is redundant. However, if prices are rigid and firms cannot adjust prices optimally in every period, firms rely on the fiscal announcement to infer productivity in the next period to set prices optimally. In other words, the strength of the signaling effect is proportional to the degree of nominal price rigidities.

The degree of risk aversion magnifies the signaling effect of fiscal policy. If households have a high degree of risk aversion (γ), they dislike swings in consumption across periods and information about the future becomes important to smooth consumption over time. The relevance of the fiscal announcement increases with the degree of risk aversion since risk-averse agents use the information in the announcement to infer the state of productivity in the next period and decide the optimal allocations that smooth consumption between periods.[10]

3.8 Numerical Simulations

We study the quantitative relevance of our theoretical results by simulating the model numerically. While we calibrate most of the parameters to standard values in the literature, we estimate the parameter ψ that determines the cyclical response of government spending to productivity in the fiscal rule, and calibrate the share of government spending using Japanese data. Our aim is to provide an initial quantitative assessment on the signalling effect of fiscal announcements. Table 2 summarizes the standard calibration of parameters.

We set the labor share (α) equal to 0.55 and the discount rate (β) equal to 0.99. We set the parameter of risk aversion (γ) equal to 2 and we will conduct extensive robustness analysis on this parameter. We set the elasticity of substitution across goods (ϵ) equal to 6, consistent with a 20% price markup, and we set the degree of price rigidities (ζ) equal to 0.5, consistent with the average

[10] See Zanetti (2014) for a discussion on the role of risk aversion in consumption-based models.

Table 2: Parameter values

Parameter	Description	Value
α	Labor share	0.55
β	Discount rate	0.99
γ	Risk aversion parameter	2.00
ϵ	Elasticity of substitution in production	6.00
ζ	Degree of price stickiness	0.50
θ	Share of government spending in steady state	0.25
P_1	Price level in period 1	1.00
σ_v^2	Variance of noise in the signal	1.00

Notes: The values for parameters α, β, γ, ϵ, and ζ are set to be consistent with the data and estimates reported in the literature. The parameter θ is the government-spending-to-GDP ratio from National Account Data from Japan.

price update of two quarters. We set the government-spending-to-GDP ratio (θ) equal to 25%, consistent with Japanese data, and we calibrate the fiscal spending shock to 5% of GDP, consistent with the fiscal expansion in Japan in 2020 relative to the long-run government-spending-to-GDP ratio from the National Account Data for the years 2014-2019. We normalize the price in period 1 (P_1) and the variance of noise in the signal (σ_v^2) to one. With this normalization, in the rest of the analysis the parameter σ_u^2 represents the prior uncertainty of agents relative to the normalized degree of precision in the signal.

We estimate the elasticity of government spending to productivity (ψ) that determines the systematic response of fiscal policy to changes in expected productivity using data on aggregate technology from the Penn World Table (version 10.0), and data on government spending from the Annual Report on National Account in Japan for the period 1980–2019. Since government spending comprises several categories, we use the three most representative classes of fiscal spending, represented by total government spending, government consumption, and public investment. We estimate our parameter of interest ψ by regressing each alternative categories of government spending on productivity using the equation:

$$\tilde{g}_t = \psi \hat{x}_t + \sum_{i=1}^{p} \rho_i \tilde{g}_{t-i} + c + u_t, \tag{34}$$

where $\tilde{g}_t$ and $\tilde{x}_t$ are the detrended series of government spending and total factor productivity, respectively, and the lagged dependent variables control for serial correlation in the error. The series are detrended using the Hamilton's (2018) regression filter, and the lag lengths, denoted

Table 3: Systematic response of fiscal policy

	Total Spending	Government Consumption	Public Investment
	(1)	(2)	(3)
Estimated value of ψ	-0.33$**$	-0.11$*$	-0.96$*$
	(0.14)	(0.06)	(0.49)
No. of lagged regressand	4	4	4
Observations	34	34	34

Notes: The data is from Penn World Table and the Annual Report on National Account in Japan for the period 1980-2019. Newey-West HAC standard errors are in parentheses. The lagged independent variables are set based on the Akaike information criterion. The 5% and 10% significant levels are denoted by $**$ and $*$, respectively.

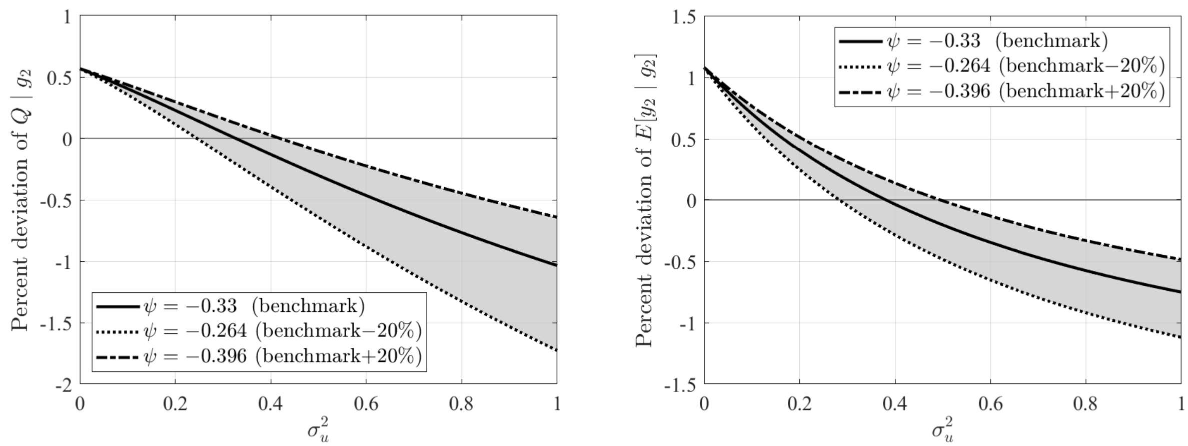
by p in equation (34), are selected based on the Akaike information criterion.[11] Table 3 shows the estimation results. The alternative estimates for ψ, shown in columns (1)–(3), are negative, ranging within values -0.11 and -0.96, and they are statistically significant. We use the value of -0.33 associated with total government spending as our benchmark values, and we conduct extensive robustness analysis on the value of this parameter.

Figure 3 shows the effect of the private sector's prior uncertainty (σ_u^2) on the percentage deviation of stock prices response to the fiscal announcement ($Q|g_2$) for alternative calibrations to the countercyclical response of fiscal policy. The solid line shows the benchmark calibration $\psi = -0.33$, and the shaded area shows responses of fiscal policy within -20% ($\psi = -0.264$, dotted line) and +20% ($\psi = -0.396$, dashed line). The figure shows that the role of prior uncertainty is quantitatively relevant in the response of stock prices to the fiscal announcement across two dimensions. First, the strength of the signaling effect increases with the spread of beliefs. When the private sector has no prior uncertainty, the response of the stock market is positive and equal to 0.5 percent from the long-run equilibrium, while when the prior uncertainty is the same as the variance of the noise (i.e., σ_u^2=1) stock prices fall by 1 percent from their long-run value, and the negative response increases non-linearly with the private sector's prior uncertainty.

Second, the signalling effect significantly diminishes with the degree in the countercyclical response of fiscal policy. As shows in Figure 3, the percentage response of stock prices to the fiscal announcement is lower when the coefficient ψ is +20% ($\psi = -0.264$, dashed line) than the benchmark calibration ($\psi = -0.33$, solid line) and the opposite realizes when the coefficient ψ is -20%

[11] In the Hamilton's regression filter, the variable is regressed on its two-years lagged value and the residuals of the regression are regarded as the detrended series. While we use the Hamilton's regression filter as our benchmark, the results are robust to the alternative detrending methods of Hodrick-Prescott (HP) filter and the band pass filter. An appendix with robustness analysis is available on request to the authors.

(a) Stock prices (b) Output



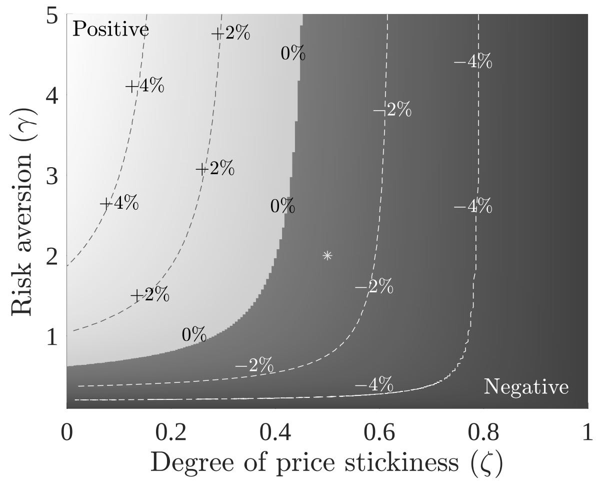
Notes: The figures illustrate the relationship between the stock price and expected output responses to the announcement of fiscal spending for period 2 and the agents' prior belief, respectively. These responses are measured by the percentage deviation from the steady-state value. The solid line shows the responses in the benchmark calibration of the system in Table 2 with $\psi = -0.33$, shown in Table 3. The dashed and dotted lines show the responses in the alternative calibrations for ψ 20% above and below the benchmark calibration, respectively.

Figure 3: Stock prices, signaling effects, and systematic response of fiscal policy

than the benchmark calibration. Those differences increase with the variance of prior beliefs, encapsulated by the parameter σ_u^2. The intuition for these results are straightforward: if the response of fiscal policy is cyclical, an announcement of a large fiscal plan is bade news about future economy conditions, and thus the announcement might generate a contraction in the economy. The strength of the negative signalling effect increases with the prior uncertainty of the private sector, in line with the tracking model in Section 2.

Finally, we show the quantitative importance of the degree of price rigidities (ζ) and risk aversion (γ) for the signaling effects of fiscal policy, as established by Lemma 1. Figure 4 shows the combinations of values for parameters ζ and γ that generates negative (dark-shaded area) and positive (light-shaded area) signaling effects to the expansionary fiscal announcement.[12] The simulations show that the effects are sizeable and the signaling effect of fiscal policy increases with the dislike of households to changes in consumption, and the inability of firms to adjust prices optimally in each period, as discussed earlier in this section.

[12] We calibrate the system with the benchmark values in Table 3 and normalize the prior uncertainty of agents to one ($\sigma_u^2 = 1$).



Notes: The dark-shaded (light-shaded) area shows values for ζ and γ that generate negative (positive) signaling effects on stock prices. The other parameters in the model are set to baseline values in Table 2, and the prior uncertainty σ_u^2 is set equal to one. And, the mark of $*$ represents the combination of ζ and γ in the benchmark.

Figure 4: signaling effects, risk aversion (γ) and price stickiness (ζ)

4 Motivating Evidence

To construct a benchmark to evaluate the role of signaling effects for the efficacy of fiscal measures, we consider three selected fiscal announcements that are unanticipated and exogenous to the economic conditions, and thus representative of the response of stock prices to exogenous fiscal policy shocks. The three fiscal spending episodes are:

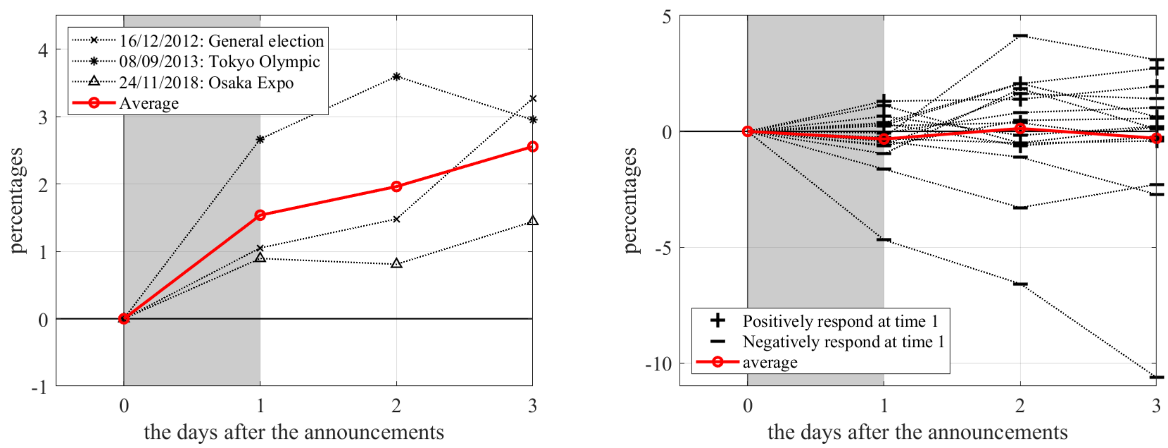
1. Victory of the Liberal Democratic Party lead by Shinzo Abe at the General Election and the announcement of "Abenomics policies" to stimulate the economy: December 16, 2012.

2. Successful bid to host the 2020 Olympics and the announcement of large public investment projects: September 8, 2013.

3. Successful bid to host the 2025 Universal Exposition and the announcement of a urban regeneration plans and infrastructure spending: November 24, 2018.

Figure 5a shows the percentage responses of Nikkei 225 index over the three subsequent days to the fiscal announcement. The entries show the cumulative sum of the residuals obtained by regressing the percentage change in stock prices on several control variables, normalizing the response

(a) Exogenous fiscal spending (b) Supplementary budgets



Notes: Figures 5a and 5b show the responses of stock prices to the fiscal announcements for three exogenous increments (panel a) and sixteen supplementary budgets (panel b). Responses are the cumulative sum of residuals obtained by regressing the percentage change in stock prices on several control variables, and thus they represent the cumulative value in the change of stock prices that is unexplained by the control variables. We normalize the response to zero on the day before the announcement. The shaded ares highlights the time of the announcement. The the y-axes reports the percentage changes. The red-solid line with circled marker shows the average value of responses. In Figure 5b the markers + and − indicate positive and negative change in stock prices on the day of the announcement.

Figure 5: Response of stock prices to fiscal announcements

on the day before the announcement to zero.[13] In our exercise the fiscal announcement occurs between time zero and one (the shaded area), and the change in stock prices at time one represents the immediate response of stock prices that cannot be explained by the movement in the control variables. The effect of the three expansionary fiscal announcements is positive on stock prices on average (red-solid line with circle markers), but differences in the responses from the average value are sizeable, ranging from around 2.5% in response to the winning bid of the 2020 Olympics to around 1% in the case of the Universal Exposition.

We compare these benchmark responses of stock prices against those of the sixteen supplementary fiscal policy measures that the Prime Minister Office announced outside the regular budget cycles over the period 2011-2020, described in Section 5.1 (see summary Table 5). Figure 5b shows that the percentage change in stock prices to the supplementary fiscal announcements covers a wide range of values, comprising positive and negative responses, and resulting in an average response

[13]The data and the estimating equations are described in the next section. We use the series of residuals from the regression to purge the response of stock prices from the effect of other factors that could affect stock prices. The explanatory variables in the regression equation are those in our benchmark specification in the next section, excluding the volatility index and fiscal indicator indexes.

of stock prices to the fiscal announcements close to zero, as evinced by the red-solid line with circle markers. On the first day after the announcement, the response of stock prices is negative in more than half of the fiscal announcements (marker $-$) and positive for the other half of responses (marker $+$). Since these sixteen supplementary budget measures are implemented outside the regular fiscal budget and are aimed to countervail the potential downturn from specific economic circumstances, the size of the fiscal announcement may convey information on the expectations of the government about the negative economic outlook. As a result, these fiscal news can exert a powerful signaling effect of fiscal announcements that lowers stock prices on impact.

For these negative or zero responses of stock prices to fiscal news to be explained by signaling effects, it is critical to assess the level of macroeconomic uncertainty when these policy announcements were made. As we will show more clearly with the help of the structural model, when macroeconomic uncertainty in the private sector is low, private beliefs about the economy are harder to move and so stock prices are less likely to be affected by the signaling component of fiscal news. In contrast, when market participants are quite uncertain about the economy, beliefs and stock prices tend to be more responsive to the arrival of news about the economy – including news about the government's view on the economy extracted from fiscal announcements. Therefore, checking if large uncertainty is correlated with the negative response of stock market prices to fiscal news is a litmus test for the existence of signaling effects.

To this end, we look into the survey expectations of households and firms at the time of the sixteen fiscal announcements. We acquire household expectations from the *Consumer Confidence Survey* that has been administered monthly by the Cabinet Office since 2004.[14] It covers 8,400 households selected from over 50 million households nationwide, excluding foreigners, students, and households living in institutions and it surveys the consumer perception on a broad range of issues including overall livelihood, asset prices, and economic growth. Respondents answers each question on the one-to-five scale: improve, improve slightly, no change, worsen slightly, and worsen. We focus on the items about the outlook for overall livelihood, asset prices, and income growth over the next six months.

We also use firm expectations from the *Short-Term Economic Survey of Enterprises in Japan*, known as the *Tankan* Survey, administered by the Bank of Japan on a quarterly frequency since

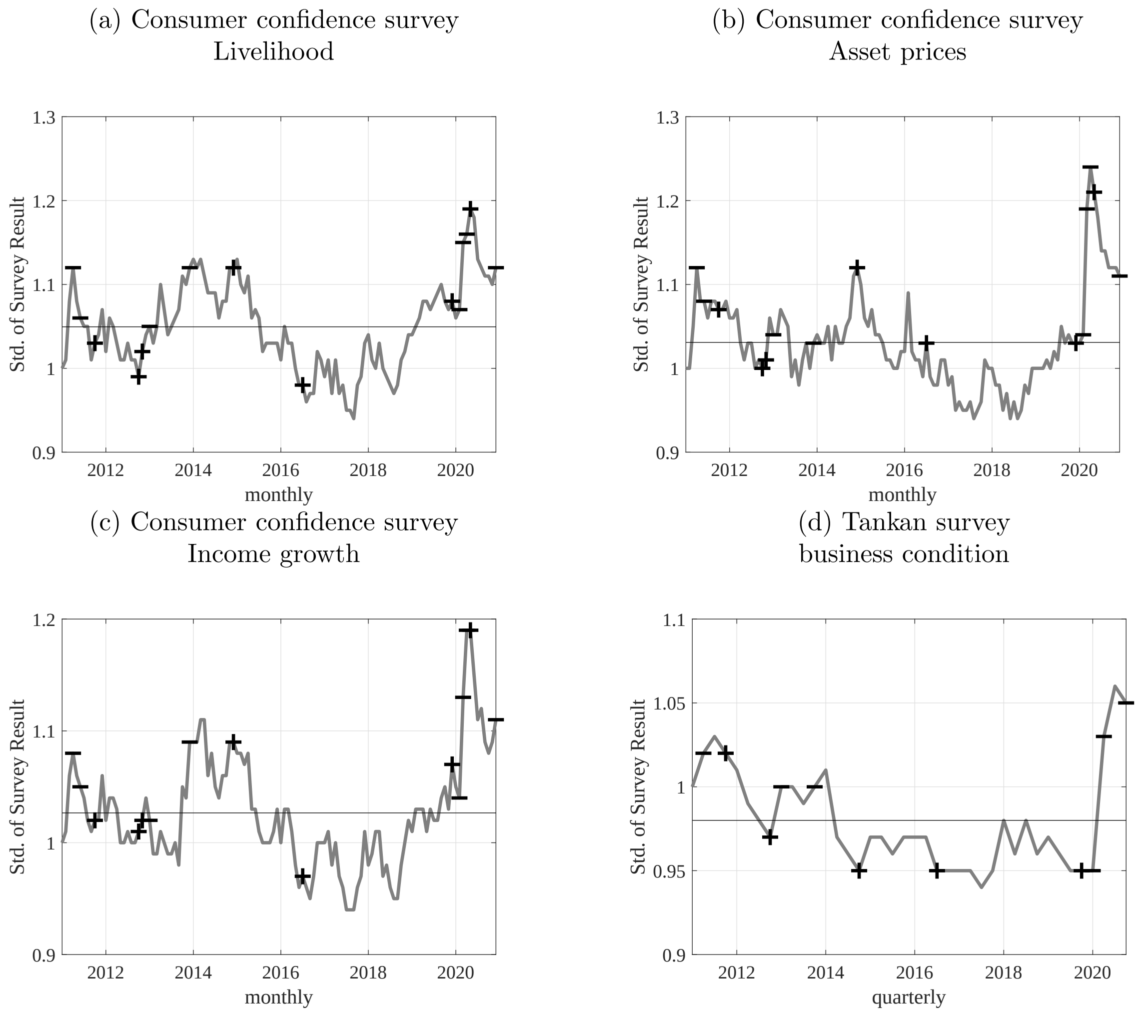
[14]The predecessor survey began in 1957, and at that time only urban households were surveyed twice a year. The current monthly survey of nationwide households has been conducted since 2004.

1974. The survey provides qualitative information about the nationwide private corporate activity in Japan. The target population is private enterprises with a capital of 20 million yen or more, it encompasses 220,000 firms and 10,000 enterprises. We use the section on the Judgment Survey of Business Conditions that mandatorily requires each legal enterprise to provide an indication on the business conditions based on the expectations of profits in the next quarter. The survey requires participants to answer questions by choosing one of the following three alternative options: favourable, not so favourable, and unfavourable.

Figures 6a – 6c show the standard deviation in the responses of household expectations from the *Consumer Confidence Survey*, related to questions about livelihood (panel a), asset prices (panel b) and income growth (panel c). The markers + and − report the sign of the percentage change of stock prices in the day after each of the sixteen announcements (described in Figure 5b). Figure 6d shows the standard deviation in the responses of firm expectations from the *Tankan* Survey, together with markers for each of the sixteen announcements. We normalize the standard deviation to be equal to one in the initial period, and the solid horizontal line represents the sample average of standard deviation for each survey.

The four panels in Figure 6 show a consistent, systematic relationship between the response of stock prices and expectations about the future: a large variance of expectations for either firms of households predicts a negative response of stock prices to the fiscal announcement. In general, the response of the stock prices is positive when the standard deviation of the expectations is low or below the historical average, while the response of stock prices tends to be negative in times of heightened uncertainty, as during the Great East Japan Earthquake in March, 2011, or the recent Covid-19 pandemic in March, 2020.

This first pass to the data provides preliminary evidence indicative of a wide range of responses of stock prices to an expansionary fiscal policy. The response of stock prices is positive when the announcement is orthogonal to the economic situation and the fiscal intervention is independent from economic conditions. Nevertheless, the response may be negative when the fiscal announcement is made to address adverse economic conditions and when households and firms expectations are more dispersed.



Notes: This figure shows the standard deviation of the answers to the *Consumer Confidence Survey* (panels a-c) in the period January 2011– December 2020, and the *Tankan Survey* (panel d) for the period 2011Q1 – 2020Q4. We compute standard deviations as follows. First, we calculate the weighted average of the results by multiplying the evaluation points for each alternative and the component ratio. We set the evaluation points in the *Consumer Confidence Survey* as to be +1 (improve), +0.75 (slightly improve), +0.5 (no change), +0.25 (worsen slightly), and 0 (worsen), and for the *Tankan* survey +1 (favorable), 0 (not so favorable), and -1 (unfavorable). Then, for each alternative, the square of the deviation between the evaluation point and weighted average is calculated at each period, and the squared root of its sum, weighted by the component ration, is used as the standard deviation. For the comparison, we normalize the standard deviation at the initial point to be equal to one. The marks of + and − in the figures are attached to be consistent with the immediate responses in Figure 5b.

Figure 6: Standard deviation of survey results and fiscal announcements

4.1 The Nikkei Volatility Index and Consumer Confidence

Expectations recorded from surveys have monthly or quarterly frequencies, while we need series with shorter frequencies to study the role of expectations for the effect of fiscal announcements. In this section, we show that the Nikkei 225 Volatility Index (Nikkei VI) – a daily measure of the expected volatility of stock prices – is strongly correlated with the dispersion in the survey expectations of households and firms shown in the previous subsection, and thus it is a good proxy for consumer confidence.

Table 4 shows the correlation coefficients between the dispersion in the survey expectations (for the survey questions about livelihood, asset prices and income growth) and the Nikkei VI converted into the monthly basis by time average. The p-values (in parentheses) test the hypothesis that the correlation between variables is equal to zero. The entries show that the correlations between the Nikkei VI and the different measures of consumer confidence from the Consumer Confidence Survey (last row) are positive at 1% significance level, indicating that the Nikkei VI robustly tracks the dispersion in the expectations from survey data.

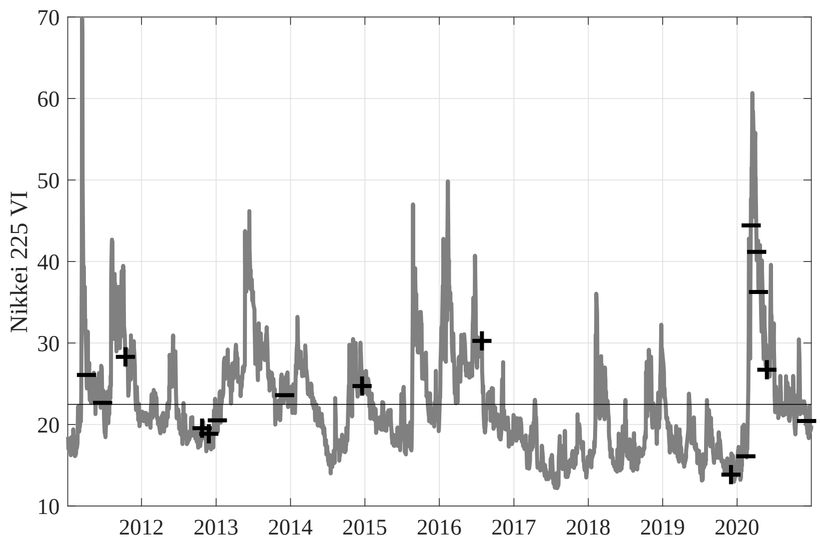
Table 4: Correlations among the consumer confidence and the Nikkei VI

	Consumer confidence survey			Nikkei VI
	Overall livelihood	Asset prices	Income growth	
Overall livelihood	1			
Asset prices	0.79 (0.00)	1		
Income growth	0.92 (0.00)	0.84 (0.00)	1	
Nikkei VI	0.35 (0.00)	0.51 (0.00)	0.33 (0.00)	1

Notes: The entries show the correlation coefficients between the standard deviations for the *Consumer Confidence Survey* (Figures 6a–6c) related to the questions about livelihood, asset prices and income growth, and the monthly Nikkei VI. The values in the parenthesis indicate the p-value for the hypothesis that the correlation between variables is insignificant.

Figure 7 shows the time profile of daily Nikkei VI with the sign of response of stock prices on the day of each fiscal announcements we considered in Figure 5b. High stock market volatility predicts a negative response (− marker) of stock prices to the fiscal announcement, while the response of stock prices tends to be positive (+ marker) when stock market volatility is low, similar to the findings from survey data in Figure 6.

In the next section, we will use the daily Nikkei VI as a proxy for confidence and assess the key drivers for the response of stock prices to fiscal announcements in a more formal local projections exercise.



Notes: This figure shows the daily variation in Nikkei 225 VI (solid thick line) and the timing of fiscal announcements (+ or − marks). The thin line represents the historical average of Nikkei 225 VI. The marks of + and − are attached in the same manner as in Figure 6.

Figure 7: Nikkei 225 VI and fiscal announcements

5 Empirical Investigation of the Signaling Effects

In this section, we estimate the impact of fiscal announcements on stock prices for the supplementary stimulus packages issued by the Prime Minister Office over the period 2011-2020. Our focus is on the signaling effect of fiscal policy – that is, whether an announcement of an expansionary fiscal package is interpreted as reflecting negative economic news by the private sector which contributes to lowering stock market prices. We focus on the supplementary stimulus packages since each of those fiscal announcements is made to counteract adverse and uncertain economic conditions and thus offers a natural experiment to study the signaling effects of fiscal policy.

5.1 The Data

We develop a new dataset that combines daily data on stock prices using Nikkei 225 average stock price index with narrative records on fiscal announcements from press releases. The Prime Minister Office of Japan announced sixteen stimulus packages of supplementary budgets from April, 2011 to December, 2020. Table 5 summarizes the date of the announcements for the sixteen supplementary fiscal stimulus packages from 2011 to 2020, reporting the date of the news release (first column), the size of fiscal spending (third column), total amount of fiscal packages (fourth column) as well as the description of what the news is about (fifth column). Fiscal spending excludes the loan from government-affiliated financial institutions and tax deferrals from total size of fiscal package.

Unlike monetary policy announcements that are released by the Bank of Japan in predetermined days during working hours of the Tokyo Stock Exchange, supplementary fiscal packages are issued irregularly, sometimes outside the opening hours of the stock market, with a posthumous formal ratification. To identify the moment of public announcement of each fiscal package, we use the *Nikkei* newspaper – the major economic and business outlet in Japan. Since we are interested in fiscal announcements, we select news releases that report the Prime Minister's orders and the size of the government intervention. The release of news about fiscal measures typically comprises three phases in Japan. In a first phase, the Prime Minister instructs the Cabinet ministers to prepare a proposal for the supplementary budget or fiscal package. In a second phase, public discussion between the government and the ruling parties reveals the approximate content of the fiscal package, but leaving uncertainty around the scale. This second phase is closed with a public announcement by the PM (or government official) on the most likely scale of the fiscal package, which is endorsed by the official approval by the Cabinet. In a third phase, the fiscal package is formally ratified by the Diet, typically without revisions since the measures are already gained support from the ruling parties and the Cabinet.[15] Our analysis primarily focuses on the second phase that entails the first official announcement by the PM who discloses the likely scale of the packages, but for robustness we will also consider the signaling effects of the other announcements.

To study the effect of fiscal announcements on stock prices, we create indicator variables equal to one on the day of each releases of information for the three distinct phases in the announcement of fiscal measures (second column).[16] Consequently, we denote with the indicator variable $\mathbb{I}\{A_t^{\text{order}}\}$ the dates when the PM orders the preparation of a proposal for the fiscal package, with the indicator variable $\mathbb{I}\{A_t^{\text{final}}\}$ the dates of the announcements on the size of the final fiscal packages, and with the

[15] In fact, we have confirmed that all budgets during our sample period are approved by the Diet as proposed by the government.

[16] We set the indicator variable equal to one on the day for the news published in evening edition as well as morning edition because the news in evening edition has been possibly released before closing the stock market as flash news. As a robustness check on the exact time of the announcements, we also use the *Nikkei Quick News* (NQN) section from *Nikkei* newspaper, which provides the title and content of each news with the timing of release in one minute increments. We find that results are consistent across specifications.

indicator variable $\mathbb{I}\{A_t^{\text{ratify}}\}$ the dates of ramifications by the Cabinet. In our benchmark analysis, we show that the announcements in the second phase on the size of the fiscal packages are the most important to signal the fiscal policy stance, while the information releases during the other phases provide insufficient or redundant and information that fails to change expectations.[17]

Table 5: Supplementary fiscal stimulus packages: 2011–2020

(1) Dates	(2) Indicators	(3) Fiscal spending	(4) Total size	(5) Description
(a) 1st Supplement Budget-2011				
30/03/2011	$\mathbb{I}\{A_{1,t}^{\text{order}}\}$	About 2 trn.	n.a.	PM stated in the Diet.
07/04/2011		About 4 trn.	n.a.	Gov. and ruling party's plan
09/04/2011	$\mathbb{I}\{A_{1,t}^{\text{final}}\}$	About 4 trn.	n.a.	Gov. finalized the skeleton.
22/04/2011	$\mathbb{I}\{A_{1,t}^{\text{ratify}}\}$	4.0153 trn.	n.a.	Ratification
(b) 2nd Supplement Budget-2011				
14/06/2011	$\mathbb{I}\{A_{2,t}^{\text{order}}\}$	n.a.	n.a.	PM's order
25/06/2011	$\mathbb{I}\{A_{2,t}^{\text{final}}\}$	About2 trn.	n.a.	Gov. finalized the outline.
05/07/2011	$\mathbb{I}\{A_{2,t}^{\text{ratify}}\}$	1.9988 trn.	n.a.	Ratification
(c) 3rd Supplement Budget-2011				
12/07/2011	$\mathbb{I}\{A_{3,t}^{\text{order}}\}$	n.a.	n.a.	PM's order
10/09/2011		About 10 trn.	n.a.	Gov. outlook
13/09/2011		More than 10 trn.	n.a.	Financial minister's outlook
16/09/2011		About 11 trn.	n.a.	Ministry of Finance's draft
27/09/2011		About 12 trn.	n.a.	Gov. and ruling party's plan
15/10/2011	$\mathbb{I}\{A_{3,t}^{\text{final}}\}$	12.1 trn.	n.a.	Gov. finalized the plan.
21/10/2011	$\mathbb{I}\{A_{3,t}^{\text{ratify}}\}$	12.1025 trn.	n.a.	Ratification
(d) Comprehensive measures to cope with yen appreciation				
18/10/2012	$\mathbb{I}\{A_{4,t}^{\text{order}}\}$	n.a.	n.a.	PM's order
25/10/2012	$\mathbb{I}\{A_{4,t}^{\text{final}}\}$	About 400 bn.	About 700 bn.	Gov. finalized the outline.
26/10/2012	$\mathbb{I}\{A_{4,t}^{\text{ratify}}\}$	400 bn.	750 bn.	Ratification
(e) Japan Recovery Acceleration Program				
16/11/2012	$\mathbb{I}\{A_{5,t}^{\text{order}}\}$	n.a.	n.a.	PM's order
27/11/2012	$\mathbb{I}\{A_{5,t}^{\text{final}}\}$	880 bn.	More than 1 trn.	Gov. finalized the outline.
30/11/2012	$\mathbb{I}\{A_{5,t}^{\text{ratify}}\}$	880.3 bn.	About 1.2 trn.	Ratification
(f) Emergency Economic Measures for the Revitalization of the Japanese Economy				
27/12/2012	$\mathbb{I}\{A_{6,t}^{\text{order}}\}$	About 10 trn.	n.a.	PM's order
08/01/2013	$\mathbb{I}\{A_{6,t}^{\text{final}}\}$	10.3 trn.	More than 20 trn.	Gov. finalized the outline
11/01/2013	$\mathbb{I}\{A_{6,t}^{\text{ratify}}\}$	10.3 trn.	20.2 trn.	Ratification
(g) Economic Measures for Realization of Virtuous Cycles				
11/09/2013	$\mathbb{I}\{A_{7,t}^{\text{order}}\}$	About 4∼5 trn.	n.a.	PM's order

(continued)

[17] An appendix available on request provides robustness analysis on results based on the indicator variables $\mathbb{I}\{A_t^{\text{order}}\}$ and $\mathbb{I}\{A_t^{\text{ratify}}\}$.

Table 5 – Supplementary fiscal stimulus packages: 2011–2019 (*continued)*

(1) Dates	(2) Indicators	(3) Fiscal spending	(4) Total size	(5) Description
13/09/2013		More than 5 trn.	n.a.	PM's plan
03/12/2013		More than 5 trn.	n.a.	Gov. draft
04/12/2013	$\mathbb{I}\{A^{\text{final}}_{7,t}\}$	About 5.5. trn.	More than 18 trn.	Gov. finalized the scale.
06/12/2013	$\mathbb{I}\{A^{\text{ratify}}_{7,t}\}$	5.5 trn.	18.6 trn.	Ratification
(h) Immediate Economic Measures for Extending Virtuous Cycles to Local Economies				
19/11/2014	$\mathbb{I}\{A^{\text{order}}_{8,t}\}$	2∼3 trn.	n.a.	PM's order
19/12/2014	$\mathbb{I}\{A^{\text{final}}_{8,t}\}$	About 3.5 trn.	n.a.	Gov. finalized the plan.
28/12/2014	$\mathbb{I}\{A^{\text{ratify}}_{8,t}\}$	3.5 trn.	n.a.	Ratification
(i) Economic Measures for Realizing Investment for the Future				
13/07/2016	$\mathbb{I}\{A^{\text{order}}_{9,t}\}$	n.a.	n.a.	PM's order
15/07/2016		n.a.	More than 10 trn.	Gov. draft
26/07/2016		About 6 trn.	More than 20 trn.	Gov. skeleton
28/07/2016		More than 6 trn.	More than 28 trn.	PM stated in speech.
29/07/2016	$\mathbb{I}\{A^{\text{final}}_{9,t}\}$	About 7 trn.	More than 28 trn.	Gov. finalized the plan.
03/08/2016	$\mathbb{I}\{A^{\text{ratify}}_{9,t}\}$	7.5 trn.	28.1 trn.	Ratification
(j) Comprehensive Economic Measures to Create a Future with Security and Growth				
08/11/2019	$\mathbb{I}\{A^{\text{order}}_{10,t}\}$	About 5 trn.	n.a.	PM's order
30/11/2019		About 8 trn.	More than 20 trn.	Gov. plan
03/12/2019	$\mathbb{I}\{A^{\text{final}}_{10,t}\}$	About 8 trn.	More than 20 trn.	Gov. finalized the plan.
06/12/2019	$\mathbb{I}\{A^{\text{ratify}}_{10,t}\}$	7.6 trn.	26 trn.	Ratification
(k) 1st Novel Coronavirus Disease Emergency Response Package				
07/02/2020	$\mathbb{I}\{A^{\text{order}}_{11,t}\}$	n.a.	n.a.	PM announced in the Diet.
14/02/2020	$\mathbb{I}\{A^{\text{final}}_{11,t}\}$,$\mathbb{I}\{A^{\text{ratify}}_{11,t}\}$	15.3 bn.	500 bn.	PM declared the plan and ratification
(l) 2nd Novel Coronavirus Disease Emergency Response Package				
01/03/2020	$\mathbb{I}\{A^{\text{order}}_{12,t}\}$	n.a.	n.a.	PM stated in the press conference.
09/03/2020		n.a.	More than 1 trn.	Gov. plan.
11/03/2020	$\mathbb{I}\{A^{\text{final}}_{12,t}\}$, $\mathbb{I}\{A^{\text{ratify}}_{12,t}\}$	More than 430 bn.	1.6 trn.	Gov. finalized and ratified the plan.
(m) Emergency Economic Measures to Cope with COVID-19 (1st Supplementary Budget-2020)				
29/03/2020	$\mathbb{I}\{A^{\text{order}}_{13,t}\}$	n.a.	More than 56 trn.	PM's order
04/04/2020		More than 20 trn.	More than 56 trn.	Gov. plan
07/04/2020	$\mathbb{I}\{A^{\text{final}}_{13,t}\}$	More than 20 trn.	About 108 trn.	PM stated in the press conference.
08/04/2020	$\mathbb{I}\{A^{\text{ratify}}_{13,t}\}$	16.8 trn.	108 trn.	Ratification
16/04/2020	$\mathbb{I}\{A^{\text{final}}_{14,t}\}$	+ more than 12 trn.		PM ordered to modify the plan.
21/04/2020	$\mathbb{I}\{A^{\text{ratify}}_{14,t}\}$	25.69 trn.	117.1 trn.	Ratification
(n) 2nd Supplementary Budget-2020				
15/05/2020	$\mathbb{I}\{A^{\text{order}}_{14,t}\}$	n.a.	n.a.	PM's order
25/05/2020		n.a.	More than 100 trn.	Gov. plan
27/05/2020	$\mathbb{I}\{A^{\text{final}}_{15,t}\}$	31.9114 trn.	About 117.1 trn.	Gov. finalized the plan.
28/05/2020	$\mathbb{I}\{A^{\text{ratify}}_{15,t}\}$	31.9114 trn.	About 117.1 trn.	Ratification

(continued)

Table 5 – Supplementary fiscal stimulus packages: 2011–2019 (*continued)*

(1) Dates	(2) Indicators	(3) Fiscal spending	(4) Total size	(5) Description
(o) Comprehensive Economic Measures to Secure People's Lives and Livelihoods toward Relief and Hope				
10/11/2020	$\mathbb{I}\{A^{\text{order}}_{15,t}\}$	n.a.	n.a.	PM's order
08/12/2020	$\mathbb{I}\{A^{\text{final}}_{16,t}\}$	30.7 trn.	About 73.6 trn.	Gov. finalized the plan.
09/12/2020	$\mathbb{I}\{A^{\text{ratify}}_{16,t}\}$	30.8 trn.	73.6 trn.	Ratification

Notes: The table summarizes the change in the scale of fiscal stimulus packages and supplementary budgets in the period 2011-2020, as reported in the *Nikkei* newspaper. The supplementary budgets in 2011, i.e., (a)-(c), were issued for the recovery from the Great East Japan Earthquake that occurred on March 11, 2011. Fiscal stimulus packages in (d) and (e) were designed to cope with the appreciation of the Yen to facilitate the recovery from the earthquake. Fiscal stimulus packages (f)-(j) were part of the Abenomics policies. Fiscal packages in 2020, (k)-(o), were issues to counteract the downturn during the COVID-19 pandemic. The fiscal stimulus package (m) was ratified the first time on April 7, 2020, and it was re-ratified on April 21, 2020.

5.2 The Effect of Fiscal Announcements on Stock Prices

To study the effect of fiscal announcements on stock prices, we use the local projection method by Jordà (2005) that entails important advantages over the standard VAR approach for our analysis. First, it dispenses from the restrictive assumption of recursive identifications that allows the exact timing of news releases to identify the effect of fiscal announcements. Second, it enables the estimation of non-linearities and state-dependence in the effect of fiscal spending, which are found important the studies by Auerbach and Gorodnichenko (2013), Ghassibe and Zanetti (2020), Fernández-Villaverde et al. (2022) and Jo and Zubairy (2022). Third, local projections yield robust standard errors while allowing for serial correlation in the error terms, as discussed in Plagborg-Moller and Wolf (2021).

We implement our analysis on the changes in the daily index of stock prices by using the log differentials of the Nikkei 225 average in each period (Δs_t). The sample size includes 2,445 observations over the sample period. We estimate the cumulative response of stock prices to fiscal announcements at horizon h using the following benchmark specification:

$$\sum_{j=0}^{h} \Delta s_{t+j} = \alpha_h \mathbb{I}\{A_t^{\text{final}}\} + \beta_h \mathbb{I}\{A_t^{\text{final}}\} \times VI_t + Z_{t-1}\gamma' + \delta_h + e_{t+h} \tag{35}$$

where $\sum_{j=0}^{h} \Delta s_{t+j}$ is the cumulative response of the change in stock prices for the different daily horizons $h = 0, 1, 2, ...$, and $\mathbb{I}\{A_t^{\text{final}}\}$ is our indicator variable that takes a value equal to one for each of the fiscal announcements about the finalization of supplementary fiscal packages, listed in Table 5. The coefficients α_h and β_h are of central interest to our analysis. In the regression, the cumulative response of stock prices at time $t+h$ to the fiscal announcement at time t is given by $\alpha_h + \beta_h \cdot VI_t$, implying that the response of the stock prices to the fiscal announcement may depend on the volatility in the stock market, proxied by the Volatility Index. We normalize VI_t to have zero mean and unit variance, so that the coefficient α_h represents the cumulative response of stock prices to the announcement under the average VI_t. The coefficient β_h captures the interaction between the response of stock prices and the volatility in the stock market. The coefficient δ_h is a horizon-specific constant term that captures the average stock returns in each horizon h, and consequently the value of $\alpha_h + \beta_h \cdot VI_t$ can be interpreted as an impulse-response function that indicates the extent to which the stock prices deviate from the average movement in response to the fiscal announcement. The variable Z_{t-1} denotes the vector of control variables that includes the lagged change in the volatility index (ΔVI_{t-1}), the Dow Jones Industrial Average for the US Stock Market at trading closure in the preceding day ($\Delta DJIA_{t-1}$), the long-short spread between ten-year and one-year Japanese Government Bond (JGB) ($\Delta spread^{sl}_{t-1}$), the spread between stock yield and ten-year JGB ($\Delta spread\_yield_{t-1}$), the nominal effective exchange rate ($\Delta neer_{t-1}$), and one lag in the change in stock prices (Δs_{t-1}).[18]

Column (1) in Table 6 shows the estimation coefficients for our benchmark specification in equation (35) based on the indicator variable $\mathbb{I}\{A_t^{\text{final}}\}$ that records the dates of the announcements of the final size of the fiscal package to the public. The coefficient β_h on the interaction term $\mathbb{I}\{A_t^{\text{final}}\} \times VI_t$ is equal to -0.660, and it is statistically significant, while the coefficient α_h on the indicator variable $\mathbb{I}\{A_t^{\text{final}}\}$ is statistically insignificant. Thus, the effect of fiscal announcements on the stock prices is insignificant under an average volatility, but it becomes significant and negative when uncertainty heightens and increases from the mean value. The negative estimated value for the parameter β_h shows that fiscal announcements convey negative signaling effects about future economic conditions which depress stock prices when stock market volatility is above the historical average.

[18]These control variables account for possible serial correlation in the errors, changes in stock prices originated by movements in the US stock market, and credit supply and financial conditions. Chen and Rogoff (2003) show a strong relationship between movements in t US stock prices and the Japanese stock market. Gilchrist and Zakrajšek (2012), Gortz et al. (2021) and Ikeda et al. (2021) show that movements in yield spreads are important to control for changes in expectations about future economic conditions.

Columns (2) and (3) in Table 6 report alternative specifications that omit the interaction term (column, 2) and all the control variables with the exception of the constant term (column, 3). The results show that the interaction term between the Volatility Index and the fiscal announcements together with the additional control variables are important for the significant effect of fiscal announcements on stock prices. When we do not control for the interaction between the fiscal announcements and the volatility index, the effect of the fiscal announcements is statistically insignificant.

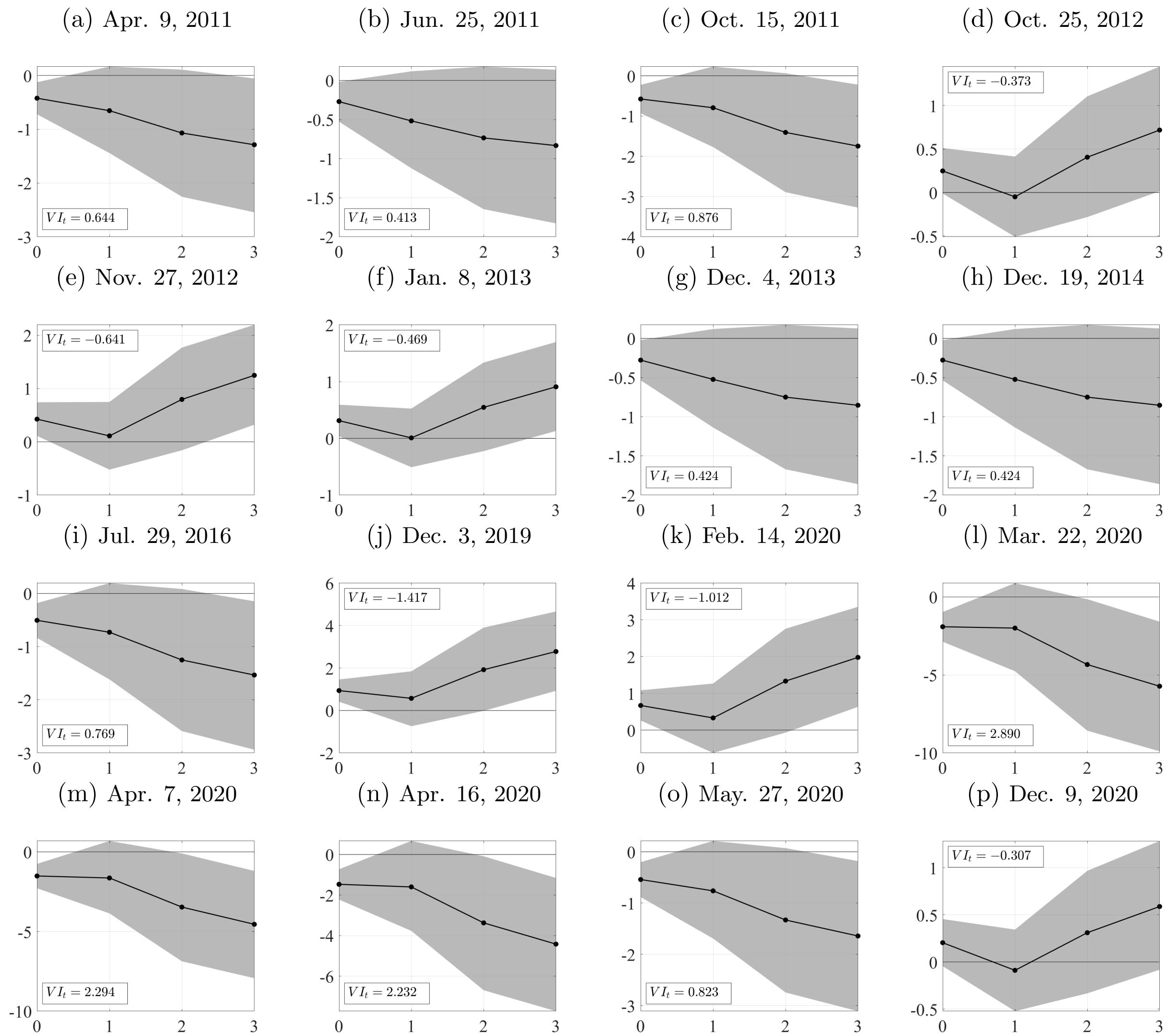
Columns (4) through (6) in Table 6 show that the benchmark results are robust across the different phases of announcements. We enrich our benchmark regression by including interaction terms between the Volatility Index and the indicator variables of the different phases of announcements. In particular, we include interactions with PM's order (column 4), ratification (column 5), and the two indicator variables together with the indicator variable for the announcement of the final size of fiscal package (column 6). The results of our benchmark estimation are unchanged, and the coefficient on interaction term between the final announcement and the volatility index remains significantly negative across all specifications, providing evidence that announcements that include the final size of the fiscal package conveys non-redundant information that decreases stock prices.

Our results establish strong and robust negative impact of fiscal announcements in periods of elevated uncertainty on stock prices. The findings show that the announcement on the size of supplementary fiscal package conveys non-redundant information on future economic conditions that generates a strong signaling effect. Public announcements that omit the disclosure of the size of the fiscal package provide insufficient and redundant information and entail no signaling effect.

Table 6: Impact effects of fiscal announcements on stock prices

VARIABLES	Δs_t					
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{I}\{A_t^{\text{final}}\}$	0.002	-0.308	-0.081	-0.000	0.006	0.004
	(0.228)	(0.322)	(0.292)	(0.230)	(0.235)	(0.236)
$\mathbb{I}\{A_t^{\text{final}}\} * VI_t$	-0.660**		-0.070	-0.668**	-0.683***	-0.692***
	(0.330)		(0.322)	(0.335)	(0.271)	(0.275)
$\mathbb{I}\{A_t^{\text{order}}\} * VI_t$				0.040		0.043
				(0.130)		(0.129)
$\mathbb{I}\{A_t^{\text{ratify}}\} * VI_t$					0.058	0.061
					(0.493)	(0.492)
$\Delta DJIA_{t-1}$	0.558***	0.554***		0.558***	0.558***	0.558***
	(0.044)	(0.045)		(0.044)	(0.043)	(0.044)
ΔVI_{t-1}	0.134	0.135		0.133	0.135	0.133
	(0.224)	(0.225)		(0.225)	(0.224)	(0.225)
$\Delta spread_{t-1}^{sl}$	0.285	0.342		0.292	0.286	0.293
	(0.488)	(0.480)		(0.489)	(0.489)	(0.490)
$\Delta stock\_yield_{t-1}$	-0.896	-0.917		-0.865	-0.911	-0.878
	(1.953)	(1.997)		(1.959)	(1.938)	(1.947)
$\Delta neer_{t-1}$	-0.448***	-0.442***		-0.449***	-0.448***	-0.448***
	(0.099)	(0.102)		(0.099)	(0.098)	(0.098)
Δs_{t-1}	-0.102**	-0.099*		-0.102**	-0.102**	-0.102**
	(0.060)	(0.061)		(0.060)	(0.060)	(0.060)
Constant	0.029*	0.029	0.041*	0.028	0.028*	0.028
	(0.022)	(0.022)	(0.027)	(0.022)	(0.022)	(0.022)
Control	yes	yes	no	yes	yes	yes
Interaction term	yes	no	yes	yes	yes	yes
Observations	2,445	2,445	2,445	2,445	2,445	2,445
Adj. R-squared	0.210	0.208	-0.000	0.210	0.210	0.210

Notes: Newey-West HAC standard errors are in parentheses. The 1%, 5% and 10% significant levels are denoted by $***$, $**$ and $*$, respectively.



Notes: The figure shows the impulse responses of stock prices to each fiscal announcement. The solid line with circles and the shaded areas are the responses and the 68% confidence bands derived from the model with the interaction term. Note that the response in the model with interaction term depends on the value of Nikkei VI denoted in each panel, thereby resulting in the different results at each time of announcement.

Figure 8: Responses of stock prices to fiscal announcements (68% band)

The solid line with circle markers in Figure 8 shows the cumulative responses of stock prices to fiscal announcements from our benchmark regression (Column 1 of Table 6), and the shaded area reports the 68% confidence interval. Each panel reports the Nikkei VI index at the time of each announcements, normalized to have zero mean and unitary variance, such that a positive (negative) value for the index indicates that uncertainty is above (below) the historical average.

These estimates show that a high Nikkei IV predicts a reduction in stock prices, as encapsulated by the negative coefficient on the interaction term in equation (35). In particular, the figure reports the response of stock prices for the sixteen announcements during the sample period, starting from April 7, 2011 (top-left entry) and ending to December 8, 2020 (bottom-right entry). There is a strong negative relation between fiscal announcements and the volatility index. Fiscal announcements are expansionary when the volatility index is close to zero or negative (i.e., uncertainty below average), such as during the announcements on October 25, 2021, November 27, 2012, January 8, 2013, December 3, 2019, February 11, 2020, and December 8, 2020. Instead, fiscal announcements are contractionary when the volatility index is positive (i.e., uncertainty above average) like for the announcements on March 10, 2020, April 7, 2020, and April 16, 2020.

To sum up, our results show that while fiscal announcements that are exogenous to economic conditions have a positive impact on stock prices, the announcements entail negative signaling effects on the stock prices when they are in response to adverse economic conditions against a backdrop of heightened macroeconomic uncertainty. The next section develops a model that rationalizes these results.

6 The Real Effects of Fiscal Announcements

TBW

7 Conclusions

We constructed a novel dataset to study the empirical relevance of signaling effects of fiscal stimuli that combines daily data on stock prices with narrative records from press releases on a set of extraordinary fiscal packages introduced by the Japanese government over the period 2011-2020. Since the special budgetary measures are linked with unanticipated and large fiscal packages designed to combat a recession, they can potentially reveal information about the government's view on the future economic outlook, and therefore provide a signal to the private sector on future economic conditions. Overall our analysis suggests that the signaling effects may dampen significantly the effect of a fiscal stimulus when uncertainty is elevated and confidence is low. The signaling effect erodes the power of a fiscal stimulus by instilling pessimism among economic agents. We showed that this interplay between the private sector prior uncertainty and the magnitude of signaling effects is consistent with the theory of signaling effects.

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A Appendix

A.1 Signal Extraction Problem

Notice that agents know their expectations (i.e., $X_{t|t} \in I_t^p$.) Hence, after plugging the policy function into the law of motion of the economic variable, we obtain the following state-space model for the signal extraction problem:[19]

$$\tilde{X}_t = \frac{\gamma}{1-\alpha\gamma}u_t + \frac{1}{1-\alpha\gamma}\varepsilon_t, \tag{A.1}$$

$$\tilde{a}_t = \alpha\tilde{X}_t + u_t, \tag{A.2}$$

$$\tilde{s}_t = \tilde{X}_t + \xi_t, \tag{A.3}$$

where $\tilde{X}_t \equiv X_t - \lambda/(1-\alpha\gamma)X_{t|t}$, $\tilde{a}_t \equiv a_t - \alpha\lambda/(1-\alpha\gamma)X_{t|t}$, and $\tilde{s}_t \equiv s_t - \lambda/(1-\alpha\gamma)X_{t|t}$. Notice that $\{\tilde{a}_t, \tilde{s}_t\} \in I_t^p$.

This can be written in matrix form as follows:

$$\tilde{X}_t = \mathbf{R}\mathbf{z}_t, \tag{A.4}$$

$$\mathbf{y}_t = \mathbf{D}\tilde{X}_t + \mathbf{e}_t, \tag{A.5}$$

where $\mathbf{z}_t = [u_t \quad \varepsilon_t]'$, $\mathbf{e}_t = [u_t \quad \xi_t]'$, $\mathbf{y}_t = [\tilde{a}_t \quad \tilde{s}_t]'$, $\mathbf{D} = [\alpha \quad 1]'$,

$$\mathbf{R} = \begin{bmatrix} \frac{\gamma}{(1-\alpha\gamma)} & \frac{1}{(1-\alpha\gamma)} \end{bmatrix}. \tag{A.6}$$

The Kalman gain vector, $\mathbf{K}$, can be shown to be given by

$$\mathbf{K} = \left(\mathbf{R}\Sigma_z\mathbf{R}'\mathbf{D}' + \mathbf{R}\mathbf{V}\right)\mathbf{F}^{-1}, \tag{A.7}$$

where

$$\Sigma_z = \begin{bmatrix} \sigma_u^2 & 0 \\ 0 & \sigma_\varepsilon^2 \end{bmatrix}, \tag{A.8}$$

$$\mathbf{V} = E\left(\mathbf{z}_t\mathbf{e}_t'\right) = \begin{bmatrix} \sigma_u^2 & 0 \\ 0 & 0 \end{bmatrix}, \tag{A.9}$$

$$\mathbf{F} = E\left(y_t y_t'\right) = \mathbf{D}\left(\mathbf{R}\Sigma_z\mathbf{R}'\right)\mathbf{D}' + \Sigma_e + \mathbf{DRV} + (\mathbf{DRV})', \tag{A.10}$$

$$\Sigma_e = \begin{bmatrix} \sigma_u^2 & 0 \\ 0 & \sigma_\xi^2 \end{bmatrix}, \tag{A.11}$$

and the law of motion of the private sector's expectations, $X_{t|t} \equiv E\left(X_t|I_t^p\right)$, can be, thereby, expressed as follows:

[19] Unlike Nimark (2008) and Melosi (2017), agents do not have private information and, thereby, have the same expectations about the economic variable, X_t.

$$\tilde{X}_{t|t} = \mathbf{K} \left[\begin{array}{c} \tilde{a}_t \\ \tilde{s}_t \end{array} \right] = \mathbf{K} \left[\begin{array}{c} \left[\frac{\alpha\gamma}{1-\alpha\gamma} + 1\right] u_t + \frac{\alpha}{1-\alpha\gamma}\varepsilon_t \\ \frac{\gamma}{1-\alpha\gamma}u_t + \frac{1}{1-\alpha\gamma}\varepsilon_t + \xi_t \end{array} \right]. \tag{A.12}$$

From the definition of $\tilde{X}_{t|t}$, we obtain

$$X_t = \tilde{X}_t + \frac{\lambda}{1-\alpha\gamma} X_{t|t} \tag{A.13}$$

Applying the expectation operator on both sides of the equation yields

$$X_{t|t} = \tilde{X}_{t|t} + \frac{\lambda}{1-\alpha\gamma} X_{t|t} \tag{A.14}$$

and after re-arranging

$$X_{t|t} = \frac{1-\alpha\gamma}{1-\alpha\gamma-\lambda} \tilde{X}_{t|t} \tag{A.15}$$

By plugging equation (A.15) into equation (A.13) we obtain

$$X_t = \tilde{X}_t + \frac{\lambda}{1-\alpha\gamma-\lambda} \tilde{X}_{t|t} \tag{A.16}$$

The system of equations (A.4), (A.12), (A.15), and (A.16) is the solution to the model.

A.2 Derivation of the posterior distribution for a_2

This Appendix derives the posterior distribution of productivity in period 2 using the Bayes' rule, that is, $\pi(a_2 \mid g_2) \propto f(g_2 \mid a_2)\pi(a_2)$. From equations (9) and (10), the prior density function and the likelihood function are respectively given by:

$$\pi(a_2) = \frac{1}{\sqrt{2\pi\sigma_f^2}} \exp\left\{ -\frac{(a_2 - a_1)^2}{2\sigma_u^2} \right\},$$

and

$$f(g_2 \mid a_2) \equiv f(\tilde{a}_2 \mid a_2) = \frac{1}{\sqrt{2\pi\sigma_v^2}} \left\{ \frac{(\tilde{a}_2 - a_2)^2}{2\sigma_v^2} \right\},$$

where we note that the likelihood function of g_2 conditioning on a_2 is equivalent to that of $\tilde{a}_2$ because private agents perfectly infer the signal $\tilde{a}_2$ from g_2. We apply the Bayes' theorem to calculate the conditional posterior density function of a_2, which yields:[20]

$$\begin{aligned}\pi(a_2 \mid g_2) &\equiv \pi(a_2 \mid \tilde{a}_2) \\ &\propto f(\tilde{a}_2 \mid a_2)\pi(a_2) \\ &\propto \exp\left\{-\frac{1}{2}\left[\frac{(a_2-a_1)^2}{\sigma_u^2}+\frac{(\tilde{a}_2-a_2)^2}{\sigma_v^2}\right]\right\} \\ &\propto \exp\left\{-\frac{1}{2}\left[\frac{(a_2-(1/\sigma_u^2+1/\sigma_v^2)^{-1}(\sigma_f^{-2}a_1+\sigma_g^{-2}\tilde{a}_2))^2}{(1/\sigma_u^2+1/\sigma_v^2)^{-1}}\right]\right\} \\ &= \exp\left\{-\frac{(a_2-\hat{a}_2)^2}{2\hat{\sigma}^2}\right\},\end{aligned}$$

where

$$\hat{a}_2 = \frac{\hat{\sigma}^2}{\sigma_u^2}a_1 + \frac{\hat{\sigma}^2}{\sigma_v^2}\tilde{a}_2, \quad \text{and} \quad \hat{\sigma}^2 = \left(\frac{1}{\sigma_u^2}+\frac{1}{\sigma_v^2}\right)^{-1}.$$

Therefore, the posterior distribution is a normal distribution with mean $\hat{a}_2$ and variance $\hat{\sigma}_2$, as outlined in equations (12) and (13).

A.3 Model solution

The Euler and labor-supply equations from the household maximization problem are:

$$\left(\frac{1}{c_1}\right)^{\gamma} = \beta R_1 E_1 \frac{P_1}{P_2}\left(\frac{1}{c_2}\right)^{\gamma}, \tag{A.17}$$

$$\frac{W_t}{P_t} = \chi c_t^{\gamma}. \tag{A.18}$$

Given a_1 and P_1, the fiscal authority sets public expenditure equal to $g_1 = g_{ss}\left(\exp\{a_1\}\right)^{\psi}$. From equations (A.18), (24), (26) and (18) we derive the equations for the labor supply, consumption and nominal wages in period 1:

$$W_1 = \chi c_1^{\gamma}, \tag{A.19}$$

$$W_1 = \frac{\varepsilon-1}{\varepsilon}\alpha e^{E_0[a_1]} n_1^{\alpha-1}, \tag{A.20}$$

$$c_1 = e^{a_1} n_1^{\alpha} - g_1. \tag{A.21}$$

After updating the beliefs on period 2's productivity to $E_1[a_2 \mid g_2]$, intermediate goods firms

[20] Here, we transform the third equality to the fourth equality using the following identity:

$$\frac{(z-\alpha_1)^2}{\beta_1} + \frac{(z-\alpha_2)^2}{\beta_2} = \frac{(z-\chi)^2}{\delta} + \frac{(\alpha_1-\alpha_2)^2}{\beta_1+\beta_2},$$

where $\delta^{-1} = \beta_1^{-1} + \beta^{-1}$ and $\chi = \delta(\beta_1^{-1}\alpha_1 + \beta_2^{-1}\alpha_2)$.

sets P_2^* to satisfy the following system of equations:

$$
\begin{aligned}
P_2^* &= \frac{\varepsilon}{\varepsilon-1}\frac{E_1[W_2 \mid g_2]}{\alpha e^{E_1[a_2|g_2]}E_1[n_2 \mid g_2]^{\alpha-1}}, && \text{(A.22)}\\
P_2^{1-\varepsilon} &= (1-\zeta)P_1^{1-\varepsilon}+\zeta(P_2^*)^{1-\varepsilon}, && \text{(A.23)}\\
\frac{E_1[W_2 \mid g_2]}{P_2} &= \chi(E_1[c_2 \mid g_2])^{\gamma}, && \text{(A.24)}\\
E_1[c_2 \mid g_2] &= e^{E_1[a_2|g_2]}(E_1[n_2 \mid g_2])^{\alpha}-g_2, && \text{(A.25)}\\
E_1[W_2 \mid g_2] &= W_1. && \text{(A.26)}
\end{aligned}
$$

Finally, after observing the realization of a_2 in period 2, the labor supply, consumption and nominal wage at period 2 is determined as in equations (A.19)-(A.21).

A.4 Model steady state

Given the steady-state values for $n_{ss} = \bar{n}$, $P_{ss} = 1$, $a_{ss} = 0$ and $g_{ss} = \theta y_{ss}$, we derive the steady-state value of consumption from the market clearing condition and production function as:

$$c_{ss} = (1-\theta)n_{ss}^{\alpha}. \tag{A.27}$$

The free parameter χ is determined by optimal pricing rule and intra-temporal optimal condition:

$$0 = \left(\frac{\varepsilon-1}{\varepsilon}\right)\alpha n_{ss}^{\alpha-1} - \chi c_{ss}^{\gamma}. \tag{A.28}$$

The intra-temporal optimal condition gives us the steady-state value of nominal wage as $W_{ss} = \chi c_{ss}^{\gamma}$. Finally, nominal interest rate in this economy becomes $R = 1/\beta$ from the Euler equation evaluated in the steady-state.

A.5 Linear system and the response of stock prices to the fiscal announcment

This section derives the response of stock prices to the fiscal announcement. To derive the analytical properties of the response of stock prices to the fiscal announcement, we log-linearize the equilibrium conditions around the steady state. Under the assumption that the economy is in the steady state in period 1, the log-linearized version of equilibrium conditions (A.17), (A.18), (22), (23), (26) and government spending rule (25) are the following:

$$
\begin{gathered}
\hat{P}_2 = -\gamma\hat{c}_2^g,\\
\hat{W}_2^g = \gamma\hat{c}_2^g,\\
\hat{P}_2^* = \hat{W}_2^g - \hat{a}_2 + (1-\alpha)\hat{n}_2^g,\\
\hat{P}_2 = (1-\zeta)\hat{P}_2^*,\\
\hat{c}_2^g = \frac{1}{1-\theta}\hat{a}_2^g + \frac{\alpha}{1-\theta}\hat{a}_2 - \frac{\theta}{1-\theta}\hat{g}_2,\\
\hat{g}_2 = \psi\tilde{a}_2.
\end{gathered} \tag{A.29}
$$

where we define $\hat{X}_2 \equiv \ln(X_2/X_{ss})$ and $X_2^g \equiv E_1[X_2 \mid g_2]$ except for the signal and posterior beliefs of productivity in period 2, denoted by $\tilde{a}_2$ and $\hat{a}_2$. Those productivity variables are originally measured as the deviation from the steady state since $a_{ss} = 0$. Thus, equation (13) can be regarded as the deviation of the posterior beliefs on productivity in period 2 from its steady state. By the assumption of being in the steady state at period 1, equation (13) can be represented as:

$$\hat{a}_2 = \frac{\omega}{1+\omega}\tilde{a}_2 \tag{A.30}$$

where $\omega \equiv \sigma_u^2/\sigma_v^2$. The log-linearized version of expected dividends and stock prices conditional on g_2 are given by:

$$\begin{aligned} \hat{D}_2^g &= \frac{\varepsilon}{\varepsilon-(\varepsilon-1)\alpha}\left(\hat{P}_2+\hat{y}_2^g\right) - \frac{(\varepsilon-1)\alpha}{\varepsilon-(\varepsilon-1)\alpha}\left(\hat{W}_2^g+\hat{n}_2^g\right) \\ \hat{Q}^g &= \frac{\beta}{1+\beta}\hat{D}_2^g \end{aligned} \tag{A.31}$$

After some algebraic manipulation, we can derive $\hat{n}_2^g$, $\hat{P}_2$, and $\hat{y}_2^g$ as a function of $\hat{g}_2$ as follows:

$$\begin{aligned} \hat{n}_2^g &= \left[\frac{1}{(1-\alpha)(1-\theta)(1-\zeta)+\alpha\gamma}\left\{\theta\gamma + \frac{((1-\theta)(1-\zeta)-\gamma)\omega}{(1+\omega)\psi}\right\}\right]\hat{g}_2, \\ \hat{P}_2 &= \left[\frac{1}{(1-\alpha)(1-\theta)(1-\zeta)+\alpha\gamma}\left\{(1-\alpha)(1-\zeta)\theta\gamma + \frac{\gamma(1-\zeta)\omega}{(1+\omega)\psi}\right\}\right]\hat{g}_2, \\ \hat{y}_2^g &= \left[\frac{1}{(1-\alpha)(1-\theta)(1-\zeta)+\alpha\gamma}\left\{\alpha\gamma\theta + \frac{(1-\theta)(1-\zeta)}{(1+\omega)\psi}\right\}\right]\hat{g}_2, \end{aligned} \tag{A.32}$$

and $\hat{W}_2^g = 0$. Plugging equations (A.32) into equation (A.31), the analytical solution of expected dividends in period 2 is given by:

$$\begin{aligned} \hat{D}_2^g \;=\; & \frac{\gamma\theta\{(1-\alpha)(1-\zeta)\varepsilon+\alpha\}}{\{\alpha+(1-\alpha)\varepsilon\}\{(1-\alpha)(1-\theta)(1-\zeta)+\alpha\gamma\}}\hat{g}_2 \\ & + \frac{(1-\theta)(1-\zeta)\{\alpha+(1-\alpha)\varepsilon\}+\gamma\{(\varepsilon-1)\alpha-\varepsilon(1-\zeta)\}}{\{\alpha+(1-\alpha)\varepsilon\}\{(1-\alpha)(1-\theta)(1-\zeta)+\alpha\gamma\}}\cdot\frac{\omega}{(1+\omega)\psi}\hat{g}_2. \end{aligned} \tag{A.33}$$

A.6 Proof of Lemma 1. Sign of the signaling effects of fiscal policy

This section proofs Lemma 1. We discuss the condition under which a signaling effect of government spending (i.e., κ_g^{Signal} in (29)) is negative for countercyclical response of fiscal policy ($\psi < 0$). The signaling effect turns to be negative if

$$(1-\theta)(1-\zeta)\{\alpha+(1-\alpha)\varepsilon\}+\gamma\{(\varepsilon-1)\alpha-\varepsilon(1-\zeta)\} > 0. \tag{A.34}$$

This inequality can be rewritten as

$$(1-\zeta)[(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon] > -\alpha\gamma(\varepsilon-1). \tag{A.35}$$

Since the sign of the left-hand side of the inequality is ambiguous, we will consider each of the two cases.

The first case is $(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon>0$, namely:

$$\gamma<(1-\theta)\frac{\alpha+(1-\alpha)\varepsilon}{\varepsilon}. \tag{A.36}$$

Then, inequality (A.35) can be transformed as

$$1-\zeta>\frac{-\alpha\gamma(\varepsilon-1)}{(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon}, \tag{A.37}$$

and this inequality is always satisfied for a possible value of $0<\zeta<1$ because the right-hand side of inequality is negative.

In the case of $(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon<0$, inequality (A.35) can be written as

$$1-\zeta<\frac{-\alpha\gamma(\varepsilon-1)}{(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon}, \tag{A.38}$$

for

$$\gamma>(1-\theta)\frac{\alpha+(1-\alpha)\varepsilon}{\varepsilon}. \tag{A.39}$$

It is noticed that inequality (A.38) is always satisfied again for a possible value of ζ in the case of

$$-\alpha\gamma(\varepsilon-1)<(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon \quad\Leftrightarrow\quad \gamma<1-\theta \tag{A.40}$$

because the right-hand side of (A.38) exceed one. On the contrary, the signaling effect turns to be positive if and only if

$$\gamma>1-\theta, \quad \text{and} \quad 1-\zeta>\frac{-\alpha\gamma(\varepsilon-1)}{(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon}. \tag{A.41}$$

Namely, it is possible that a signaling effect of fiscal announcements become positive for countercyclical response of fiscal policy in the case of low degree of price rigidities and high risk aversion. However, the limit of ζ that satisfies inequality (A.41) as γ approaches infinity is obtained by l'Hôpital's rule as

$$\zeta<\lim_{\gamma\to\infty}\left\{1-\frac{-\alpha\gamma(\varepsilon-1)}{(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon}\right\}=1-\frac{(\varepsilon-1)\alpha}{\varepsilon}. \tag{A.42}$$

For infinite risk aversion, the limit of threshold in ζ is 0.54 in our benchmark of $\alpha=0.55$ and $\varepsilon=6$, but this constraint seems not to be binding unless risk aversion is extremely high in the range of price rigidities usually assumed in the macroeconomic literature.

A.7 Elasticity of gov. spending to productivity

The annual data of government spending and total factor productivity (TFP) are used to estimate the elasticity of government spending to productivity for the period from 1980 to 2019.

Total Factor Productivity

The source of TFP data is Penn World Table, version 10.0 (www.ggdc.net/pwt). Whereas the several series of TFP are available in this dataset, we use TFP at constant national prices (2017=1), denoted as *rtfpna* in the data source.

Government Spending

The data for government spending is downloaded from Annual Report on National Accounts 2019 (https://www.esri.cao.go.jp/en/sna/kakuhou/kakuhou_top.html), which is published from the Cabinet Office, Government of Japan. We can collect the time series of government consumption and public investment from the data source, and then total government spending is constructed as a sum of these two categories of government expenditures. The data with a baseline year of 2015 is only available from 1994 onwards, so we construct the connected series back to 1980 using the provisional estimates, which is also released by the Cabinet Office.